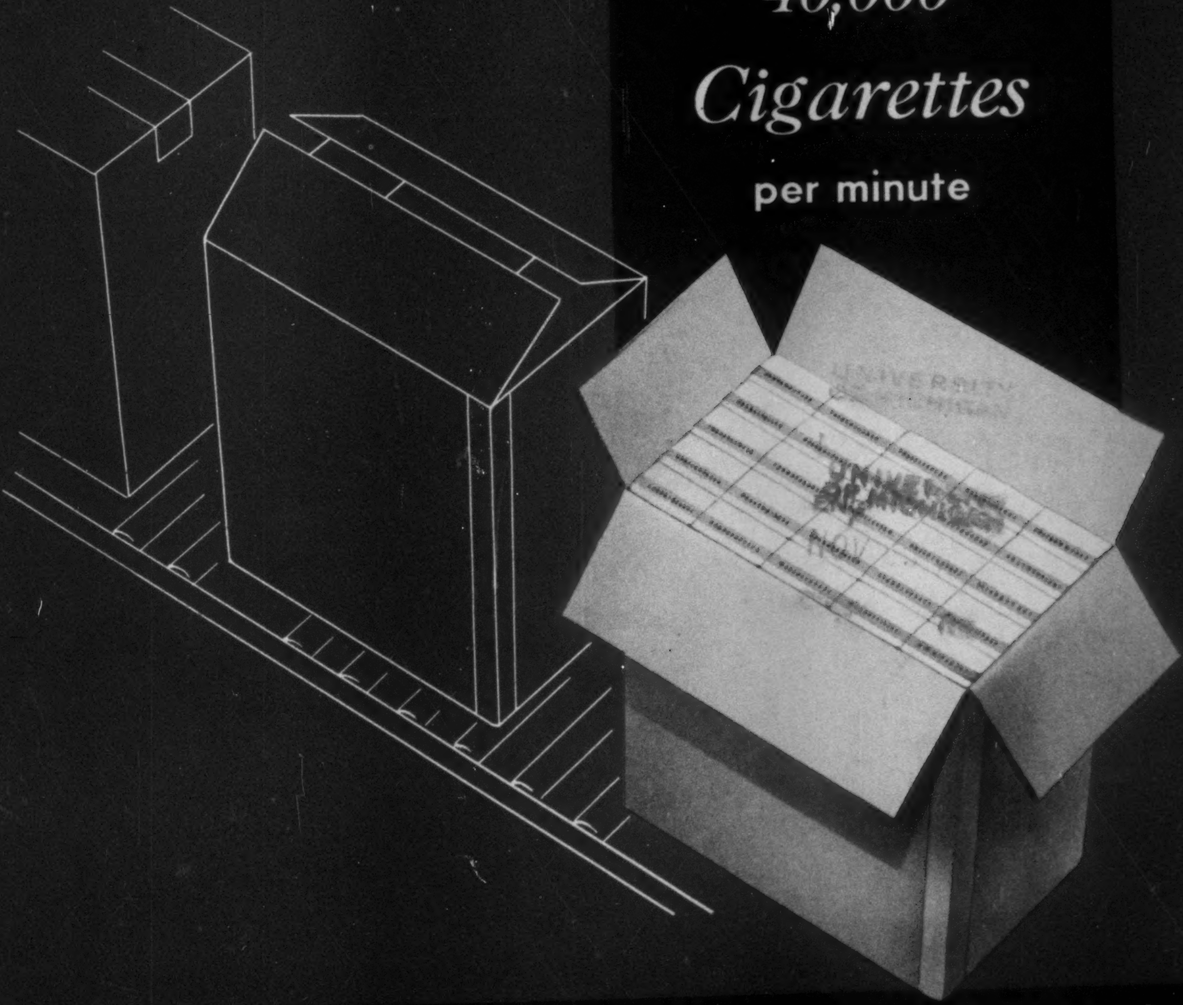
AUTOMATION

DECEMBER 1955

AUTOMATION TODAY

Packaging 40,000 Cigarettes per minute



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The Magazine of Automatic Operations

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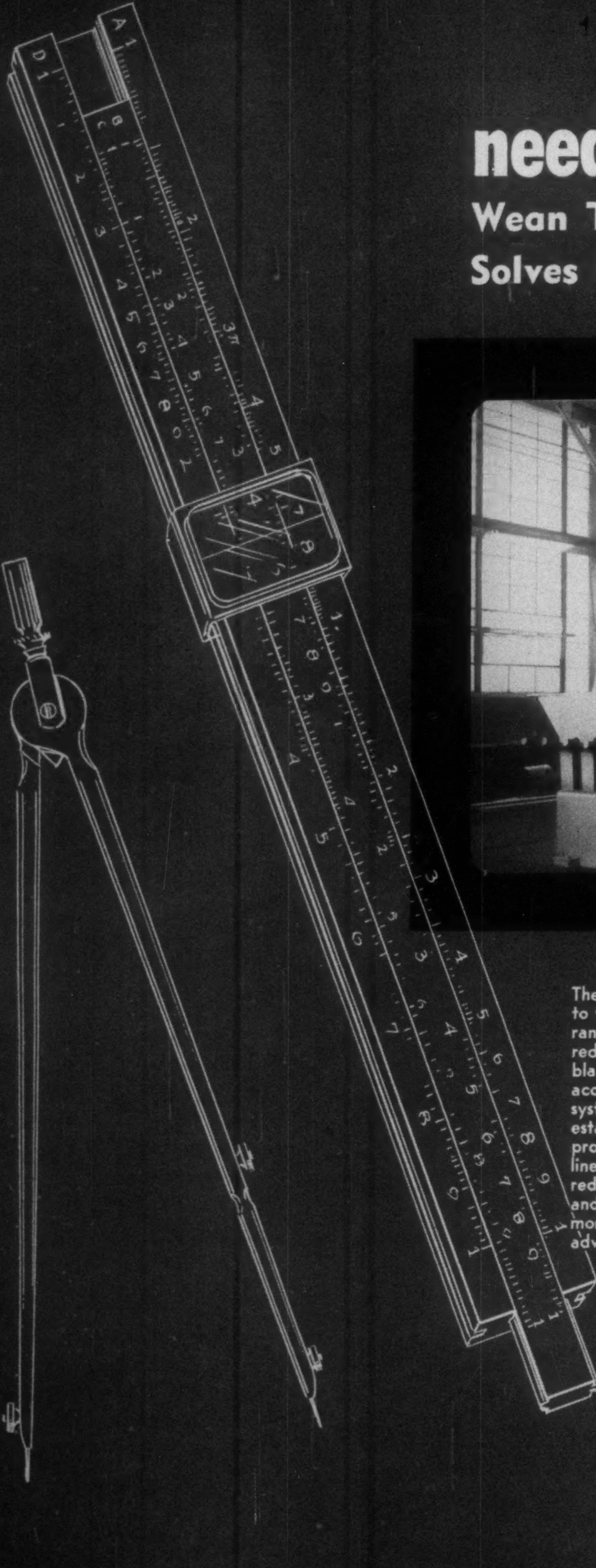
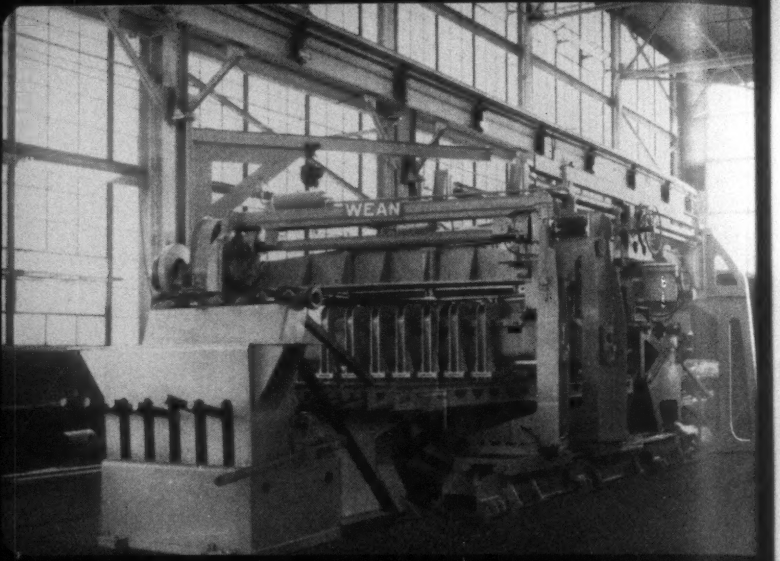


need an idea?

Wean Trapezoidal Shear Line Solves Problem for Auto Maker



The Wean Trapezoidal Shear Line was developed as an answer to the high speed blanking of irregularly shaped pieces in the broad range that can be described as trapezoids or parallelograms. This u reduces tremendously the cost of expensive die setup in major blanking presses. Two pieces are made at each index with the accuracy that can only be achieved by a measured length indexing system. The cut can range from 45° to 90° angles. The latter setti establishes the line as a straight cut-up unit with twice the normal production of conventional shear lines. At Wean, we consider thi line as another important step forward in our policy of cost reduction through progressive engineering. People in the automotive and metal fabricating fields have come to look more and more toward Wean Equipment for spectacular advances in machinery for metal processing.

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DECEMBER, 1955
Vol. 2—No. 12

AUTOMATION

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THE MAGAZINE OF AUTOMATIC OPERATIONS

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automation outlook

HARD WORKERS

". . . I am surprised whenever I hear anyone, even some of the engineers and scientists of my profession, talk about machines without human participation. We appreciate the compliment, but may I set things straight from the start—there is no development on the way, planned or even anticipated, that will make it possible for industry to operate without workers, and hard workers . . ."—*Cledo Brunetti, director, engineering research and development, Mechanical Div., General Mills Inc.*

BOON TO SAFETY

". . . automation is the greatest boon to industrial safety in the history of the industrial age. Safety is not only a matter of flesh and blood—although this is the most important consideration. Reduction in the number and severity of accidents reduces the cost of workmen's compensation and the amount of lost time. Furthermore, if your firm gains a reputation for operating safe plants, workers will be attracted to your company and will want to work for you . . ."—*W. C. Newberg, president, Dodge Div., Chrysler Corp.*

CURRENT AND INFORMATIVE

". . . nothing is as worthless as an operating report a month old. How can we expect good control of expenses unless costs are known quickly and corrections made quickly. If money is spent to buy machines and automation for factories, then every variation in results of that machine and expenses incurred by it must be known quickly. An office must automate just as the factory does. One of the greatest areas to reduce expenses is the office and we should take advantage of all means possible in mechanizing it. We should strive to secure monthly operating reports not six days after the end of the month but one day after. An annual report for a calendar year received in April is certainly ancient history—but one mailed 30 days after the end of a fiscal year is current and informative. This has been done . . ."—*J. W. Corey, president, Reliance Electric & Engineering Co.*

NEED FOR ENGINEERS

". . . the increasing need for engineers resulting from our new technical methods will be compounded by the process of automation. Many products must be redesigned from initial components to final assembly to lend themselves more readily to production by highly mechanized and electronically controlled equipment. The millions of engineering manhours required for redesign of small home appliances alone—from improvements on present models to entirely new products—can result in a tremendous drain upon engineering resources . . ."—*W. R. G. Baker, vice president, General Electric Co.*

PRODUCTIVITY AND FLEXIBILITY

". . . we can safely say that the philosophy of automation and modular construction provides many opportunities for increasing productivity and flexibility. It fulfills the needs of low volume, medium volume and mass production factories; it is the answer to the company that is concerned with growth because it provides a means for progressing from low volume to mass production at minimum cost; it provides a degree of protection against obsolescence for the mass production plant, it provides reserve production capacity for national defense . . ."—*Ralph E. Cross, executive vice president, The Cross Co.*

IF WE DID NOT

". . . in today's competitive market we use automation or improved processes wherever they are justified in order to reduce costs or improve our product. If we did not use them, we would soon find ourselves at a competitive disadvantage . . ."—*D. J. Davis, vice president, manufacturing, Ford Motor Co.*

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BPA

AUTOMATION news

Today's events and developments in the field of automation

Improved Receiving Tube Result of Extensive Research

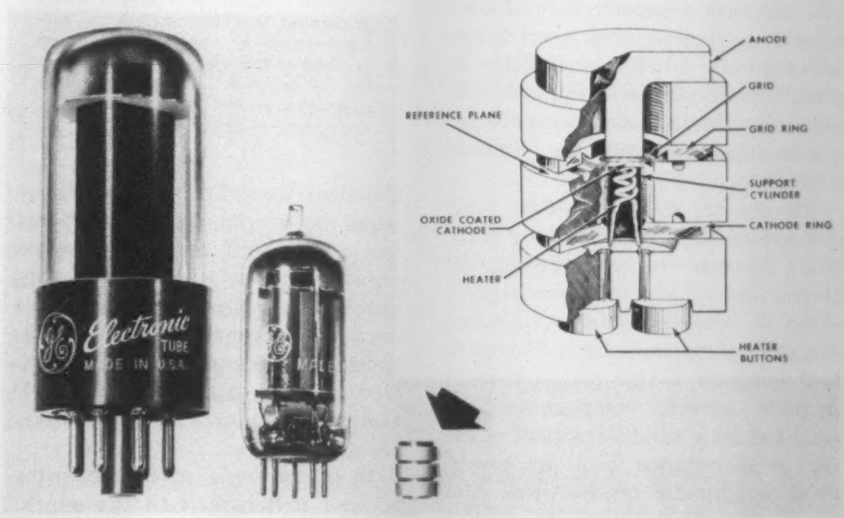
OVER A COURSE of approximately twenty years, the development of new receiving tubes has engaged the attention of General Electric engineers. It became clear early in the development program that tubes satisfying the difficult requirements of the applications contemplated for the future would call for the abandonment of glass bulbs and seals because of the limitations of this material.

During World War II, G. E. developed a metal and glass tube, now a member of the line known as lighthouse tubes. While glass construction was still used in this tube, the important connections were brought out on sheets or rods of metal rather than on wires. This reduced inductances and extended the performance of receiving tubes to higher frequencies. The next basic step involved the enclosing of the tube's elements in a smaller container, thereby making it useful at still higher frequencies. The new receiving tubes use no glass at all. Their insulators are made of new ceramics, capable of operating at very high temperatures.

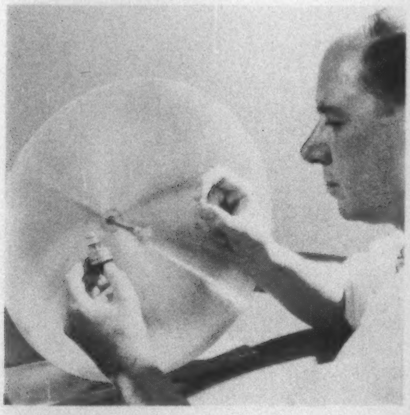
The metal parts of the new ceramic receiving triode are made of titanium, a metal actually capable of absorbing gases rather than liberating them. It has been discovered that after titanium is heated for a short period at only 700C, no further gases are liberated, even when the temperature is raised or lowered. This is in sharp contrast to the characteristics of other metals which continue to give off quantities of gas at successive temperature increases until the metals reach their melting points. The low temperature at which titanium can be degassed makes this metal uniquely valuable for use in tubes employing oxide-coated cathodes.

The construction of microminiature ceramic tubes allows the circuit to be connected to the electrodes through metallic disks. The disks form a short connection with relatively large surface. The inductance between the electrodes and the circuit is, therefore, very low, and little of the amplified signal is lost. Since the major portion of the signal can now contribute to amplifier performance, the performance is increased over that of an equivalent tube in conventional construction.

The ceramic-metal construction of these tubes gives considerable promise of successful operation at temperatures far in excess of that obtainable with conventional glass tubes. Although no rating has as yet been determined for ceramic tubes of this construction, tubes have been operated at tempera-



TREND in development of radio and television receiving tubes is illustrated by comparison of conventional glass type with plastic base, miniature type tube, and new ceramic microminiature type developed by General Electric Research Laboratory.



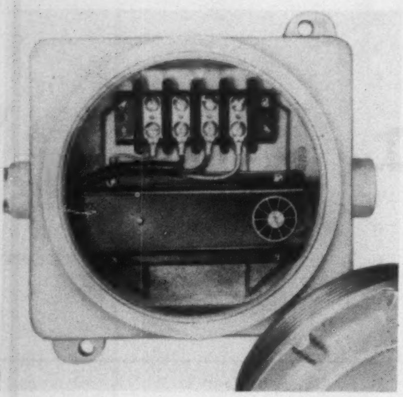
HISTORICAL predecessors of small ceramic receiving triode are shown by J. E. Beggs, scientist at the General Electric Research Laboratory. Large "lighthouse" tube was designed for radar use; smaller microwave tube was direct forerunner of 6BY4 triode.

tures above 500C for longer than 500 hours. The value of this increased temperature rating is apparent in military and industrial electronic equipment. Refrigeration equipment is often planned for high-speed military aircraft to cool the electronic equipment to an acceptable temperature level.

G. E. microminiature tube design will be more compatible with the automatic manufacture of electronic equipment than conventional receiving tubes. In addition to their small size and rugged construction, their connections are accessible from the side for "lie-flat" assembly.

Moreover, a development program has been instituted by General Electric to co-ordinate the techniques of microminiature ceramic tube and print-wire board design and manufacture. The general purpose of this program is to provide several components, assembled in a small, compact manner in accordance with the equipment designer's specification, and ready for installation in equipment as a unit. The successful conclusion of this program will simplify some problems of automatic manufacture.

RECENTLY announced expansion in production facilities of Federal Products Corp. was necessary to meet demands for in-process automatic sorting and machine control gaging equipment used on automatic production lines. Added space in renovated four-story building also provides improved facilities for manufacture of other precision instruments such as dial indicators, dial gages and Dimensionair air gages.



EXPLOSION proof vibration monitor, a product of the Beta Corp., detects mechanical malfunctions such as failing bearings or unbalance. Increase in vibration over normal, however small, can be detected. Device will actuate a warning or shut down equipment if undesirable vibration occurs.

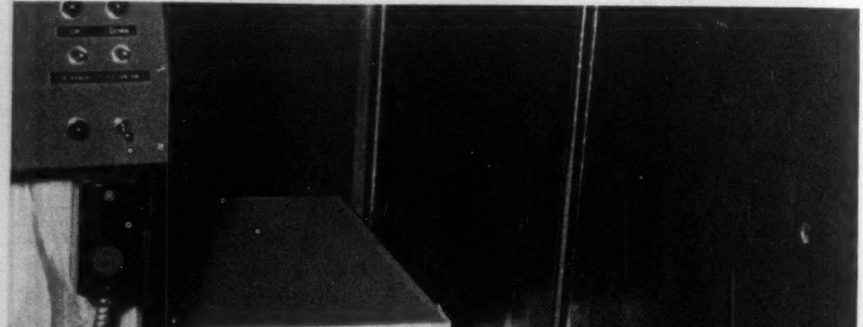
Prepunched Retail Tag Speeds Record Keeping

AUTOMATIC high speed sales tag handling system, specifically designed to provide retailers with faster market information for quick merchandise turnover, has been announced by the Samas Punched Card Div. of the Underwood Corp. The machine, operating at a speed of 7500 tags per hour, converts Dennison and Kimball merchandise tags into 40 column cards containing all the information necessary for identification such as manufacturer, style, store, department, color, price and size.

In operation, a sales tag, printed and prepunched to the specifications of the tag manufacturer, is attached to each piece of merchandise. The punched holes in the tag record the identification data. When a sale is made, a portion of the price tag is detached. A duplicate remains secured to the customer's purchase. At the end of any period, the detached portions of price tags are collected and passed through a Samas Salestag Converter for reading and reproduction into punched cards.

Once the price tags have been converted into punched cards, the cards are selected and arranged by running them through a sorter, tabulator, and summary punch. These machines automatically compute the information and final reports for management. The tag reading feature of the converter does not affect its other functions.

EXPANSION of operations in the field of rotary electromechanical products has been announced by P M Industries through the acquisition of Instrument Motors Co. Company surveys indicate, according to **Myron A. Wick Jr.**, president of P M Industries, the need for basic new designs in the commercial small motor field. Wick emphasized that the development



PROBLEM in a flower warehouse involving transfer of light-weight boxes between conveyor and elevator has been solved by use of ordinary V-belts. Dacol Corp. installation provides trouble free automatic loading and unloading of a vertical lift by means of three driven V-belts, which provide necessary traction to handle the particular operation without damaging container or product.

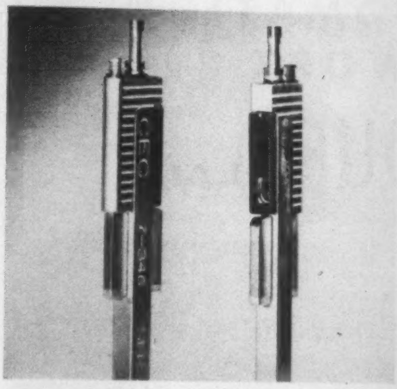
of precision synchros, resolvers and servo motors is not included in the contemplated expansion program since these products are well served by existing firms. P M Industries will continue with and expand their instrument motors and product line, including ac and dc motors, and permanent magnet devices designed for industrial applications requiring high performance.

Inherent Features Control Advancement of Automation

AUTOMATION must play a larger and larger role in industry if the American people are to keep on raising their living standards and gaining more leisure hours. **Henry F. Dever,** president of the Brown Instruments Div. of Minneapolis-Honeywell Regulator Co., is quoted as saying that by 1975 experts report our gross national product will have to be around $858 billion if our standard of living is to continue rising at the rate it has for the last 15 years. This can be done if the predicted force of 84 million workers each accounts for an expected $10,150 worth of goods annually. However, that would mean that the country would still be working the 40-hour week. If Americans are going to have all these goods, and still gain the additional leisure time of something like a 32-hour week, automation or something as good—for raising individual productivity—will have to be part of the scheme of things.

"Although expenditures for automation are rising," Dever said, "I do not feel we are very far along the road to really effective automation at present." He cited four "built-in governors" which help control the pace at which industry can progress toward full automation.

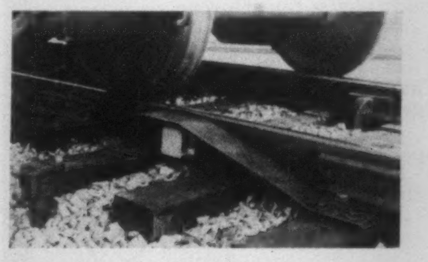
The first is the availability of equipment. There is a great need for standardization of components, cost reduction, improved adaptability and plain inventiveness. Second, there is the considerable expense of engineering and research needed to produce it, followed by solution of educational and adaptation problems. Third is the need for flexible design since every plant, every process or manufacturing operation presents unique and individual problems whose solution is found only in involved study, consultation, planning and engineering. Further, it must be economically sound. Finally, there is the very real need to be aware of the sociological implications and to move slowly with care and advance planning.



NEW series of galvanometers produced by Consolidated Engineering Corp. permit accurate recording of dynamic signals up to 200 cps without need of signal amplification between transducer and recording oscillograph. Units can be used in existing test hook-ups employing CEC galvanometers without need of circuit revisions.

Self-Adjusting TV Iris

AUTOMATIC iris, for use with closed circuit industrial television cameras, which electronically compensates for changing light levels to assure TV pictures of constant brightness and contrast has been developed by the engineering products division, Radio Corp. of America. The iris mechanism automatically masks the lens with the proper filter for any given external light condition. The automatic iris, which resembles a roll of 35 mm film is mounted with motor-driven regulators on the front of a RCA ITV-6 camera. The film serves as a filter and is continuously graded in density, from clear to heavy. Automatic or manual remote-control of the camera iris is provided by an iris control mechanism located at the ITV monitor, which may be a considerable distance from the camera. In much the same manner that a phototube responds to light, the camera's Vidicon pickup tube responds to the intensity of external light striking it. With corresponding intensity, the Vidicon activates the iris control mechanism which, in turn, triggers the motor regulators on the camera.



MASTER and intermediate retarders used in correcting speed of free moving railway cars in freight yards can be controlled automatically by device developed by Union Switch & Signal—Div. of Westinghouse Air Brake Co. Car wheel will cause rail head to deflect and, depending on weight of car, this movement is transmitted to a movable contact support to close one or more contacts. This weight information is fed into control circuit of the retarders where it is translated into a desired speed to which free moving car or cars are reduced.

FORMATION of a Special Products Division has been announced by **Benjamin Cooper,** president of Taller & Cooper Inc., engineering research and manufacturing company. Although best known as specialists in toll collection equipment for highways, tunnels and bridges, Taller & Cooper has also been engaged during the past decade in producing various other engineering devices as an outgrowth of its government work for national defense during and since World War II.

Among its other products are air pollution detectors and toxic gas controls such as carbon monoxide, hydrogen and mercury vapor analyzers; digital converters and computers; dynamic testing of fire control computers, weighing and recording instruments; automatic counting and printing systems; monitoring and telemetering systems for automatic control of industrial processes; card punching and sensing equipment; tape punching and sensing equipment; and other closed loop systems. These and other assorted developmental and manufacturing activi-

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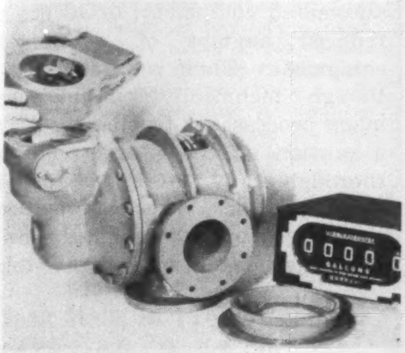
ties are to be consolidated within a single division of the company, separate and distinct from the tool equipment department.

CONSULTING industrial research firm, Arthur D. Little Inc., has announced that **Dr. Joseph Harrington** has joined the staff of the Mechanical Division. Dr. Harrington will be concerned with the design, development and fabrication of automatic machinery for the assembly of intricate equipment, particularly in the electronics field. He will also assist in the technical audit services offered by the company. He has received an Sc. D. degree from the Massachusetts Institute of Technology and has served as assistant director of research in the research division of the United Shoe Machinery Corp.

Pictures Sound for Study

SOUND measurement and analysis has been simplified by the recently developed Third Octave Spectrum Analyzer, distributed in the U.S.A. and Canada by the Brush Electronics Co. This instrument, through use of a narrow frequency band analysis, provides physical measurement data that is easily correlated to subjective tests for loudness of sound or the intensity of vibration. The Third Octave Spectrum Analyzer works in the range of frequencies from 35 to 18,000 cycles per second. Through the use of 27 fixed one-third octave band filters with the associated low noise, high gain amplifiers the instrument affords either manual or automatic switching, with the analysis data being read from a meter or graphically recorded through a connection to a level recorder. This combination analyzer and recorder permits the automatic third octave analysis and simultaneous recording of the information on a frequency preprinted chart. The chart gives the complete analysis of amplitude versus each one-third octave band of frequencies with an overall level shown at the end of the filter scanning. This automatic feature makes possible a continuous monitoring of noise levels with the analysis being recorded, thus eliminating the necessity for personnel being in attendance.



DESIGNED for attachment to a liquid meter used in the petroleum, food and chemical industries, an electrical impulse contactor activates an open-close electrical circuit at intervals proportional to the number of units measured by the meter, such as gallons, barrels, etc. Developed by the Rockwell Mfg. Co., the device operates at varying rates up to 1500 times per minute and can actuate electronic and electromagnetic counters, predetermining counters, totalizers, recording printers and sampling devices.

Quotes From Congressional Hearings on Automation

WITNESSES before the recent Congressional Subcommittee hearings on automation stressed the necessity of the new technology to the future of the American economy. The many favorable comments by leaders from industry, who from experience should be in the best position to speak authoritatively on probable effects of automation, were based primarily on the future growth of the Gross National Product and overall population as opposed to trends indicating shorter working hours and a percentage reduction in the labor force. Important labor union lead-

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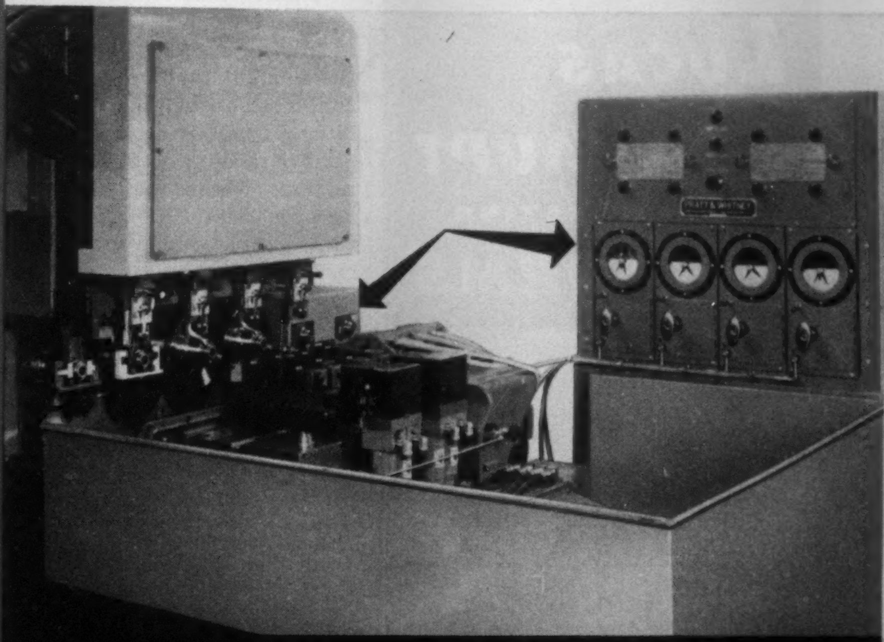

Applied to a New Britain-Gridley Automatic Dual Boring Machine, Pratt & Whitney AUTOMATION GAGING provides in-process gaging plus "feed-back" control for automatic tool resetting.

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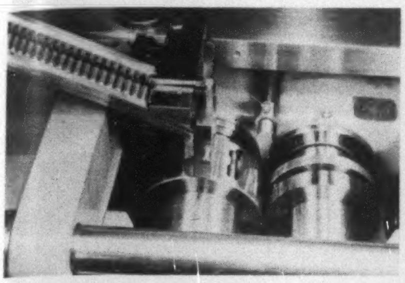
ers testifying before the Subcommittee validated at least part of these basic assumptions by a unanimity of opinion that a shorter work week is in the offing.

Some pertinent remarks by industry spokesmen at the hearings: **Robert C. Tait,** president of Stromberg-Carlson Co., Div. of General Dynamics Corp.—". . . and in passing I would like to express the thought that we need be more concerned about the availability of human engineering talent than we need be about the impact of automation. We are really getting into a serious situation in this respect, for we are graduating far fewer engineers than our industry needs now, let alone the future. Anything you gentlemen can do to stimulate our talented youth to go into engineering would be of great benefit to our country. Even if we persuaded twice as many qualified students to take up engineering in the future as are now entering these fields, it would take years before we could catch up with the shortage."

D. J. Davis, vice president-manufacturing, Ford Motor Co.—". . . although automated machinery and equipment may appear to be technically feasible with respect to a particular part, Ford cannot install them unless they can be adapted, modified, or realigned without excessive cost to accommodate the expected changes in the part. Planning for this flexibility requires expenditures of considerable time and money, and when compared with the savings obtainable from automation, we may decide to continue using nonautomated equipment, or to use a reduced amount of automated equipment. Thus, automation although technically possible for many processes is feasible for only a portion of them, and requires thorough study before it is applied to any process. Where automation can be economically applied, however, the benefits may be five-fold

TIME CONSUMING methods of handling tickets for United Air Lines are being mechanized by equipment produced by Burroughs Corp. What were formerly handwritten insertions are now produced when a special matrix is placed in the "Ticketeer". All financial and itinerary data—amount of fare, tax total—are imprinted on the matrix for automatic printing. The machine also keeps a running account on sales for easy auditing.

—increased production, lower accident rate, lower direct labor costs, improved quality in the product and reduced floor space requirements."



CONTINUOUS thread rolling of double-end studs is possible with machine built by the Landis Machine Co. Segmented design of two rolls on each spindle allows rolling of two threads of the same or different diameter and pitch in a single pass. Work is delivered from magazine to revolving workrest cage which encases one spindle. This cage indexes the studs into and away from the rolling position in a timed relation with each roll revolution.

Seek Help In Preparation Of Ordnance Handbook

ARMY ORDNANCE CORPS has initiated the preparation of a comprehensive Ordnance Engineering Design Handbook to summarize fundamental principles and basic design data. The handbook is being written to provide needed information to army ordnance and arsenal personnel and to the engineering staffs of contractors having ordnance design responsibilities. It is planned that the handbook will consist of approximately 180 sections of about 100 pages each.

Final impetus to prepare the Ordnance Engineering Design Handbook developed during the Korean War, when it became evident that availability of a central reference of ordnance design information would have materially speeded up the design, development, and production of new military weapons. In a future conflict, need for such available publications may be even more acute. The Center for Documentation and Communication Research at Western Reserve University, Cleveland, Ohio is co-operating with the Ordnance Engineering Handbook Of-

Automation

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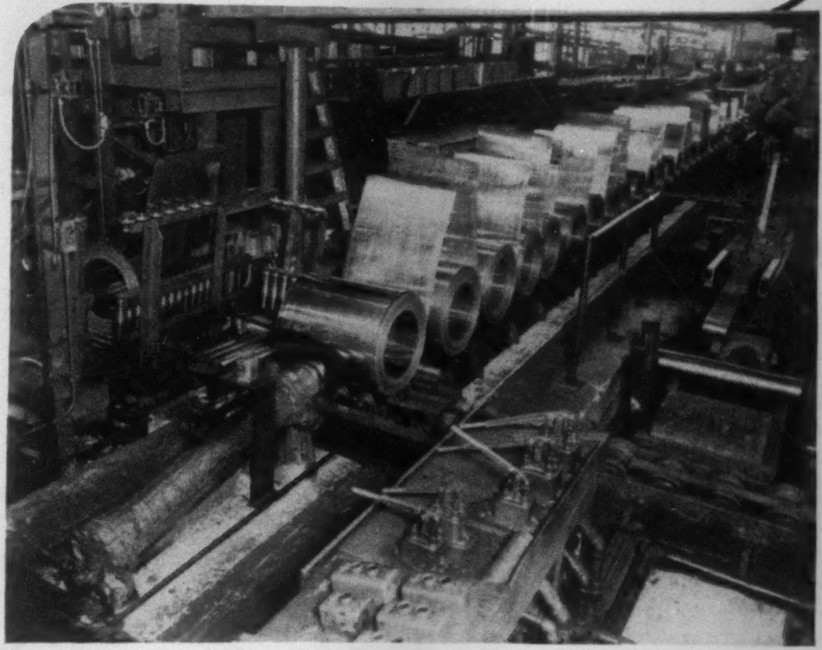

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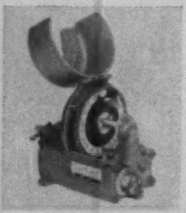

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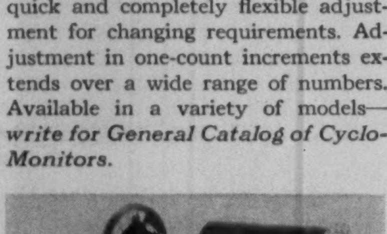

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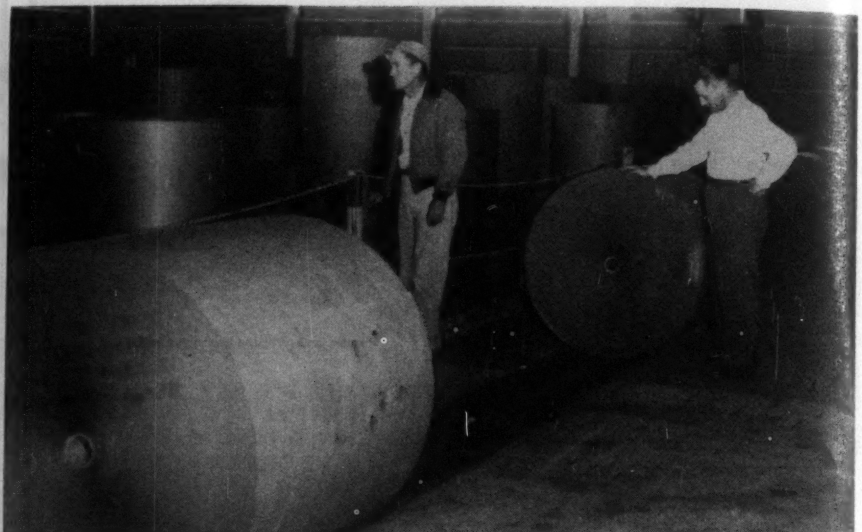

MOVING rubber sidewalk, manufactured by the B. F. Goodrich Co., runs on closely spaced steel rollers in transferring 1200-lb paper rolls from paper mill to adjoining bag plant at the St. Regis Paper Co. The rubber belt is 10 inches wide, 445 feet long and is capable of hauling 10,000 lb at one time.

fice in the important area of terminology definition and has initiated a survey of sources of information relating to terminology of importance to ordnance.

It is requested of AUTOMATION's readers that if their subject field might be of interest in ordnance work, and if they have either formal or informal collections of terminologies, glossaries, specialized dictionaries, or even references to them, please contact: Allen Kent, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

MEETINGS AND EVENTS

Dec. 5-9—

Twenty - fifth Exposition of Chemical Industries. To be held Commercial Museum and Convention Hall, Philadelphia. Additional information may be obtained from International Exposition Co., 480 Lexington Ave., New York.

Dec. 10-16—

International Atomic Exposition. To be held Public Auditorium, Cleveland, Ohio. Additional information may be obtained from International Atomic Exposition, 931 Book Bldg., Detroit 26, Mich.

Dec. 12-16—

Engineers Joint Council. Coordinating activities of 29 business and technical societies in co-sponsoring of Nuclear Engineering and Science Congress. To be held Public Auditorium, Cleveland, Ohio. Additional information may be obtained from Engineers Joint Council, 29 West 93th St., New York.

Jan. 9-13—

Society of Automotive Engineers. Annual meeting to be held Sheraton-Cadillac Hotel and Hotel Statler, Detroit. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

Jan. 16-18—

Western Reserve University. Conference on the practical utilization of recorded knowledge to be held Western Reserve University, Cleveland. Additional information may be obtained from office of Dean of the School of Library Science, Western Reserve University, Cleveland 6, Ohio.

Jan. 19-21—

Institute of Radio Engineers. National Simulation Conference sponsored by Dallas-Fort Worth Chapter of IRE Professional Group on Electronic Computers. To be held Dallas, Texas. Additional information may be obtained from J. R. Forester, 2104 Huntington, Arlington, Texas.

Jan. 23-26—
Plant Maintenance and Engineering Show. Exposition and conference to be held Convention Hall, Philadelphia, Pa. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 23-Feb. 2—
Engineering and Management Course. Special course for business executives offered by College of Engineering, School of Business Administration and University Extension of the University of California, Los Angeles. Additional information may be obtained from E. P. Coleman, University of California, Los Angeles 24, Calif.

Feb. 7-9—
Reinforced Plastics Division Conference. Eleventh annual conference sponsored by the Society of the Plastics Industry Inc. to be held Hotel Chalfonte and Haddon Hall, Atlantic City. Additional information may be obtained from society headquarters, 67 West 44th St., New York 36, N. Y.

Feb. 8-10—
Western Joint Computer Conference. To be held San Francisco, Calif. Additional information may be obtained from B. J. Bennett, Stanford Research Institute, Stanford, Calif.

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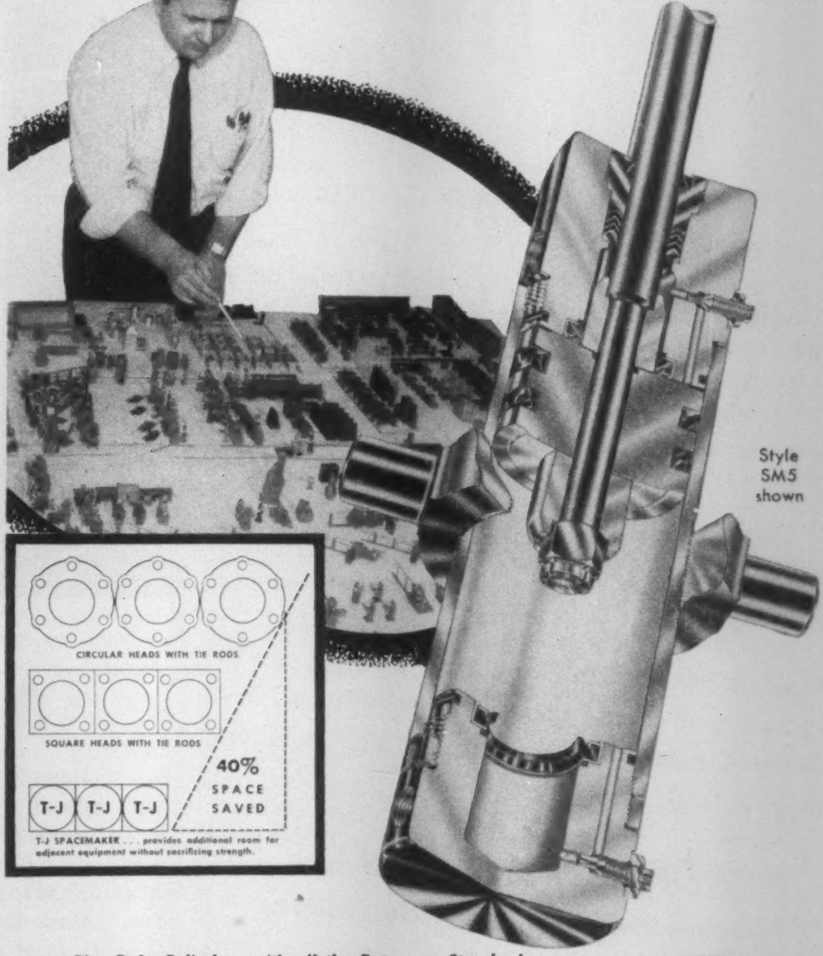
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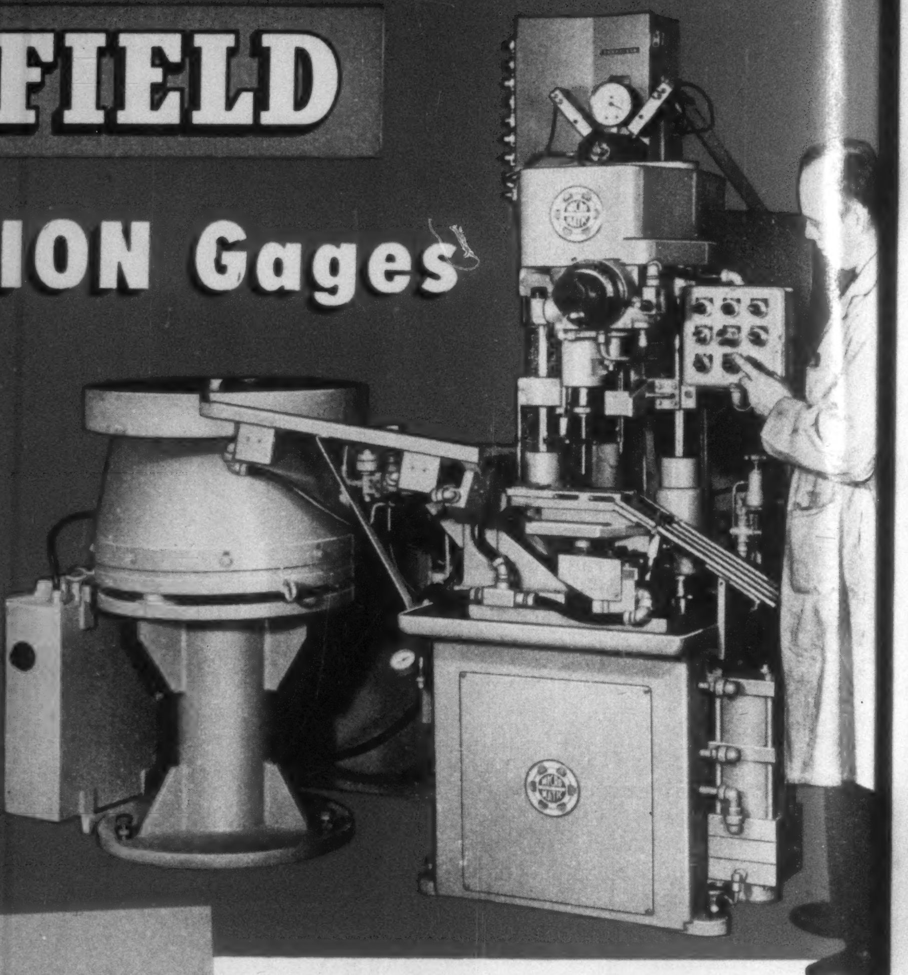

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DETROIT DATELINE

By **FLOYD G. LAWRENCE** Detroit Editor

CONGRESS HEARS OF AUTOMATION

A NIFTY HANDLE for grasping the scope of automation is provided by Bureau of Labor Statistics figures on productivity. In comparison with the period following World War I when productivity increased more than 3.5 per cent annually, the period following World War II has seen increases at a rate disappointingly similar, 3.1 to 3.6 per cent a year.

Perhaps that single fact indicates as much about the overall impact of automation as the sea of commentary which engulfed it at the recent Congressional hearings. And to some it will raise a question about whether our productivity is rising fast enough, tied in as it is with our standard of living increase.

Most clear at the hearings was the weighty conviction that automation can't be made into a political issue in the near future, except perhaps at association meetings, union conventions and sociologists' cocktail parties. But among the doodling was some handwriting on the wall worthy of note.

Longtime wallwriter Walter Reuther had an interesting preoccupation with pricing. Asking for a congressional inquiry, Reuther charged that companies aren't passing on to consumers the benefits of productivity increases. Claiming that worker pay increases are thus being diluted, he suggested a national approach to pricing policy. The theme—a long term labor objective of more voice in the economic movement of the country either through more central control of industry by government or joint labor-management councils on company policy.

Reuther evidenced a feeling that automation is a good thing providing workers get a yeoman slice of its benefits including more buying power and shorter work weeks, earlier retirement and industry-paid retraining of automation-displaced men. Behind the Reuther welcome for automation provided it is not installed "blindly and irresponsibly" are these shaping issues on the labor-management horizon.

Reply to the Reuther complaint about retraining was provided by C. C. Donovan, aide of Ford's D. J. Davis, vice president for manufacturing. Donovan pointed out that Ford began retraining about three years ago in a program involving about 6 per cent of the Ford work force, principally in engine machining and press line operations. Less than 10,000 Ford workers work on these automated lines. Meanwhile other witnesses cited the lack of sufficient engineers and technicians as limiting the national work force in its rise to higher skills.

AUTOMATION

"Senator, this is our automatic lubrication system."

General Electric Co. President Ralph Cordiner estimated that his company spends almost $40 million a year in training and retraining employees, noted that "We try to plan any substantial technological changes in such a way that normal attrition of our work force will absorb the shift in employment."

Against this, however, spoke James Carey, CIO secretary-treasurer who perhaps most closely indicated labor's bargaining attitude. Said Carey, "Although academic students of the social impact of automation speak about the raising of skills in the long run, a major problem for the existing labor force is the possibility of attempts to downgrade job classifications and cut wages. The union will do all in its power to prevent such downgrading and wage cuts."

Turning to his own electrical industry, Carey produced figures showing that from 1947 to 1955 the number of production workers increased only 14 per cent while production rose 87 per cent. But also from the electrical industry was D. G. Mitchell, president of Sylvania Electric Products blasting Reuther's proposal for a 35 or 30 hour week.

Said Mitchell, "Unless we can step up automation we will still have a 40 hour week in 1975." Citing a gross national product expectation of $850 billion compared to $382 billion today, he predicted a manpower shortage if the work week is shortened. L. L. Colbert, Chrysler Corp. president was quoted as stating that "Only automation will make it possible to fill the needs of the American people for an ever-increasing quantity of

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goods to keep pace with our rising population."

Mitchell noted that 8-million more workers would have been required to produce the goods and services demanded in 1954 if production techniques had not progressed between 1947 and 1954. On the same theme, Census Bureau Director Robert Burgess noted that between 1940 and 1950 many people were concerned about machines replacing men, yet the total number of employed increased 25 per cent to 56 million. Today the total is about 65 million, he concluded.

But Walter Buckingham Jr., associate professor of industrial management at Georgia Institute of Technology reported that in 12 cases of automation ranging from chocolate manufacturing to railroad traffic control, the reduction in employee requirements ranged from 13 per cent to 92 per cent with an average reduction in jobs of 63.4 per cent. He noted also that production in manufacturing and mining was the same at the beginning of 1954 as at the start of this year but total employment in these two industries is down almost a million.

National Association of Manufacturers' Marshall Munce pointed out that automation is "Absolutely essential if the nation is to make the next breakthrough to higher living standards. He noted that automation will and should bring about a re-allocation of job opportunities. People will shift from lines of work in which services are no longer needed in satisfying the wants of society to other and often better jobs.

"There are no problems in the offing in connection with automation except those which we may create ourselves through unwise action or foredoomed efforts to alter or distort the smooth-working of our economic destiny," he concluded.

It seems likely that future generations will look back upon the hearings, if indeed they look back upon them at all, much as we might consider a Roman senate discussion on the social implications of the wheelbarrow. Perhaps the outstanding single significance of the hearings is the fact that they were held at all—that educated people in modern society question the virtue or the necessity of increased productivity.

There was much in the hearings that is of temporal interest. Specific areas of labor aggression may be considered spelled out, congressional investigation of pricing seems likely and the traditional NAM plea for tax relief to "further automation" will undoubtedly find its way into campaign speeches. The age-old factor of temporary dislocations due to technology may draw some form of industry-financed government support, despite evidence that management is already doing more than ever before in retraining workers.

It is to be hoped that the hearings clarified in the minds of men, who should already know the nature of automation, that far from being a robot-controlled bogeyman it is the present stage of materials handling and machine control hardly more revolutionary than the automatic toaster.

But for industry men, the hearings leave a legacy, automation the bogeyman. It remains quite clear that understanding of automation, what it is and does, has not been achieved. Automation in the mind of the average man has yet to be related to better and cheaper products, new and improved job opportunities and the same kind of progress that has improved the standard of living of mankind since before history.

That the hearings were held at all is indicative of the job to be done.

> ". . . the General Motors people know what they are doing and they probably know generally about what the automotive industry is doing. General Electric knows what is happening in its plants and what is happening in the electrical industry. But no one has the total picture of what is going on in the whole field of automation. A Congressional Committee is the logical place to begin to co-ordinate and pull together the sum of our knowledge in this field. Only as we have access to that total knowledge can we begin to evaluate the impact of automation upon our economy and upon the social structure of our free society . . ."—*Walter P. Reuther, president, CIO, at the National Conference on Automation, April 14, 1955.*

AUTOMATION

An Important Step

In the approach to lower costs and better quality through application of automation principles, significant results can be attained with a step by step advance. Among the most important phases to consider in this development is inspection or error detection in the product output.

Because faultless output is the much sought aim of automation, many specialists have been led to conclude that automatic inspection is the key to successful automation. It must be conceded that manual detection of product deviations is and always has been a considerable problem and results have been poor. With modern high-speed processes, extremely stringent specifications and quantity output, adequate manual inspection becomes difficult or impossible.

Tremendous savings can be made by merely adding an automatic inspection step to present processing equipment. By this means actual yearly savings as high as $500,000 have been made. And, in contrast, the actual cost of the former variation in product quality had never been recognized.

Through addition of automatic inspection combined with feedback control, savings accrue from such items as (1) quality improvement and material conservation with closer tolerances on the end product, (2) decreased losses on changeovers, and (3) increased saleable output per production hour owing to lower scrap and production time losses.

This achievement can be a vital step in the desired direction. It must be studied carefully. Experience indicates desirability for incorporating separate inspection devices along the line linked with each production stage. To employ a single automatic final inspection device as a last stage has proved to be impractical in most cases.

Regardless of whether automation is in fully developed or only modest use, there is always present the danger of automatically turning out faulty products. Automatic sensing and measuring devices can constitute an important step in improving present operations.

EDITOR

Automatic weighing units incorporated in handling systems can control and record flow of bulk materials. Control of material flow can mean real dollar savings through improved efficiency and safety for operating equipment and improved product quality. Varieties of materials can also be accurately and continuously blended automatically in predetermined proportions. Several types of equipment and specific applications for metering bulk materials are discussed in this article

WEIGHT CONTROL OF BULK MATERIALS

Part 1—Conveyor Scales

By **S. E. GLUCK**
Director of Research and Assistant Manager
Bonded Scale & Machine Co.
Columbus, Ohio.

Courtesy, Link-Belt Co.

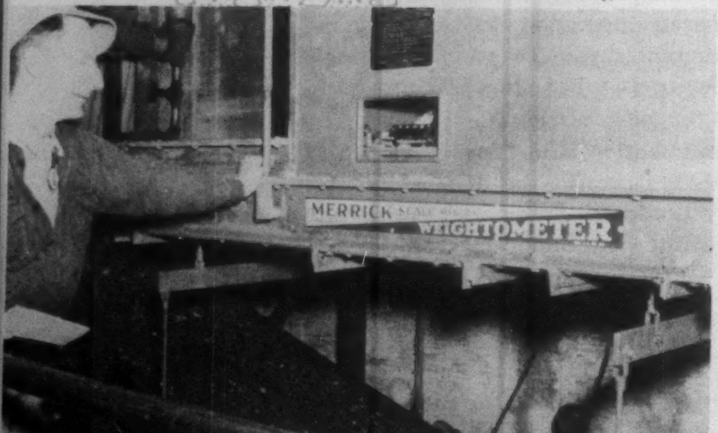


Fig. 1—A Chicago power station automatically weighs and records coal quantities as they are received, so duplicate handling is eliminated

PRECISE AND AUTOMATIC quantity control of bulk solids and liquids can be built into material-handling circuits by using automatic conveyor scales and constant weight feeders. Such equipment does not simply move material, but controls its flow to other processing equipment. At practically any point—receiving, processing, packaging, shipping, or storing—weight control with 99½ per cent accuracy is obtainable. Separate weighing operations can be eliminated, *Fig.* 1, and plant layout can often be more compact. Minerals, chemicals, food products, papers, wood products and many other materials may all be more efficiently processed with combined automatic handling and weight control. Automatic devices can continuously record quantities handled, check and correct themselves, and give warning of trouble in a production line. They can also reduce excessive machine wear elsewhere by eliminating overloading and choke-feeding or grinding circuits, screens, mixers, packaging and bagging machines, and other equipment.

Conveyor scales weigh and record the amount of material carried on a conveyor belt, without unduly affecting either the speed or the continuity of the process. There are two general types of conveyor scales: Continuously totalizing (such as the

Weightometer manufactured by Merrick Scale Mfg. Co., the Transportometer by Sintering Machinery Corp., and the Conveyoflo Meter by Builders-Providence Inc.); and intermittent types (such as the Convey-o-Weigh by Richardson Scale Co.).

Totalizing conveyor scales continuously weigh moving loads by mechanically multiplying together two variable quantities, and continually totalizing the products. The variables are the load on the conveyor belt and the speed of belt travel; and great sensitivity is required to compensate for the slightest fluctuations in belt speed, as well as rapid and accurate re-adjustment to wide variations in belt load. The load on the suspended section of the Merrick Weightometer conveyor belt is counterbalanced by a steel float, which is suspended from the long end of the scale beam and partially immersed in a pot of mercury. When the beam is deflected the float is raised until its loss of buoyancy equals the down-pull on the short end of the beam, due to the additional weight of the material on the belt. The beam corresponds to the graduated weighing beam of a platform scale, but its action is transmitted to the recording totalizer instead of being read directly. The deflection is proportional to the weight of the material on the belt, as is the upward movement of the float. The tare, or dead weight of the frame, idlers, and empty belt, is counterbalanced by loose weights. The integrator and totalizer are connected to the weighing mechanism by a sprocket and chain drive.

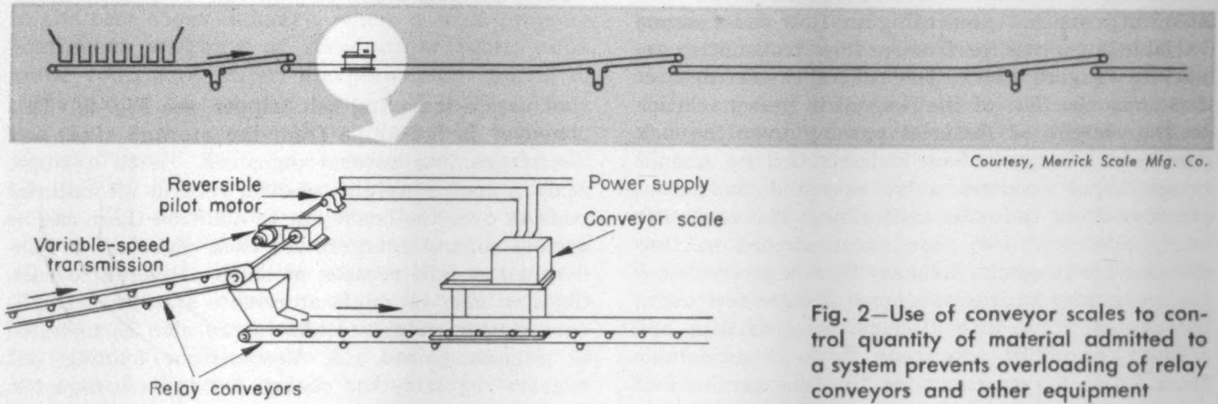
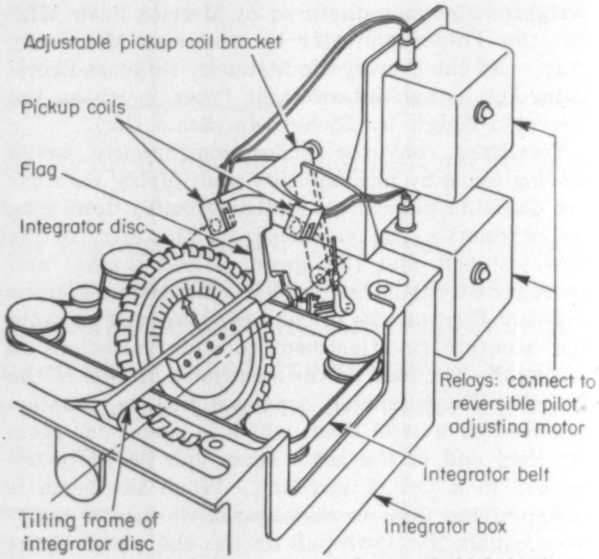

Courtesy, Merrick Scale Mfg. Co.

Fig. 2—Use of conveyor scales to control quantity of material admitted to a system prevents overloading of relay conveyors and other equipment

▶ System Protection

An automatic conveyor scale can also be used for controlling a remotely located feeder, and when the feeder is in a primary position in the process, an entire conveyor system several miles long can be guarded against overloading or damage with one automatic conveyor scale. Mining, quarrying, and construction projects and pulp and paper mills employing a system of relay conveyors, require high-horsepower motors at each transfer point. In ten miles of conveyor, as many as two dozen different units may be required, and all motor circuits must be interlocked for co-ordinated control. Without automatic weight control, such as provided by a totalizing conveyor scale, only limited control is possible. When a circuit-breaker responds to overloading, all conveyors are stopped, and it may be possible to interrupt some other processes. But the location of the overload is not immediately given, and production time is lost while the overloaded section is located and lightened. Where mixing and blending to accurate proportions is required, other serious troubles can occur. By contrast, bulk material passing through a well-designed handling system is controlled by weight at the tail end of the first conveyor, either with a continuously totalizing conveyor scale or by feeding through a constant-weight feeder. An overload is detected as it enters the system, and is immediately corrected by retarding the speed of the feeder. Thus the entire production process has one added but simplified control, and continuous records may be made. *Fig.* 2 shows a typical installation of a Weightometer to protect downstream equipment.

Components of the Weightometer include pancake pick-up coils and relays connected to the integrating mechanism, *Fig.* 3. Two adjustable switch pickups are built into the integrator, on the same axis as the tipping integrator disk. These are preset by hand to the required tonnage, with the spread of the control also manually adjustable. A metal plate attached to the integrator disk passes through the air gap between the pancake coils, forming a switch pickup without touching the coils. The plate upsets the inductance of the coils, which react on simple open-and-close relays. One coil and relay decrease feeder speed; the other coil and relay increase feeder speed. Both are connected to the circuits of a reversible pilot adjusting motor, which adjusts the ratio of a variable-speed transmission in the feeder drive. If direct current is used, the pilot motor operates a rheostat. The pilot motor can also adjust the brushes on an ac variable speed motor, or adjust the scoop when variable speed hydraulic couplings are used.


Adjustable pickup coil bracket
Pickup coils
Flag
Integrator disc
Relays: connect to reversible pilot adjusting motor
Integrator belt
Tilting frame of integrator disc
Integrator box

Courtesy, Merrick Scale Mfg. Co.

Fig. 3—Continuously totalizing conveyor scales require integrators to compute total flow from belt speed and increments of belt load. The unit shown also includes means to control increase and decrease of material flow to maintain a desired flow rate

▶ Ratio and Batch Size Control

In heavy media separation of ores and flotation of concentrates, electric and pneumatic controls can be used for accurate control of the ratio of reagent to ore, as in *Fig.* 4. In one installation ore is weighed continuously on an 18-inch troughed belt conveyor at a rate varying between 75 and 90 tons per hour. A Foxboro transmitter mounted within the head of the Weightometer operates on supply air pressure of 15 to 17 psi. The pressure transmitted is varied from 3 to 15 psi in relation to the weight of ore passing. At a remote location is a Foxboro recording ratio controller which receives the variable air pressure representing ore flow and a second variable air pressure from a flow transmitter reporting reagent flow. The controller increases or decreases the flow of the reagent in preset relation to the weight of material passing over the belt conveyor. Reagent flow is controlled by a wide range V-port control valve operated by output pressure from the ratio controller. The controller is equipped with two pens, one to record ore flow and one for reagent. Reagent flow is proportioned for a constant hydrostatic head of eight feet above the control valve with atmospheric discharge, and reagent at 190F. Reagent flow is adjustable from 3.5 to 5.5 gpm and for 100 tons per hour of ore.

The pulp and paper industry has devised many specific applications. In some mills, the continuously totalizing scale is mounted on a conveyor that uses a traveling belt tripper, see *Fig.* 5. This conveyor is fed chips from the storage silos, and discharges into several digesters. With a single scale, a master weight totalizer records all material passing over the conveyor. In addition there can be remote control counters for each digester, and individual weight records of chips delivered to each digester may be made at remote stations. Duplicate master weight totalizers can also be installed at remote points. A Veeder-Root loading out counter regulates the charge fed to each digester. It is preset to the required tonnage and, when the scale has recorded that amount, an alarm can be sounded or the handling system stopped. The addition of a delay relay insures that all weighed ma-

Courtesy, Merrick Scale Mfg. Co.

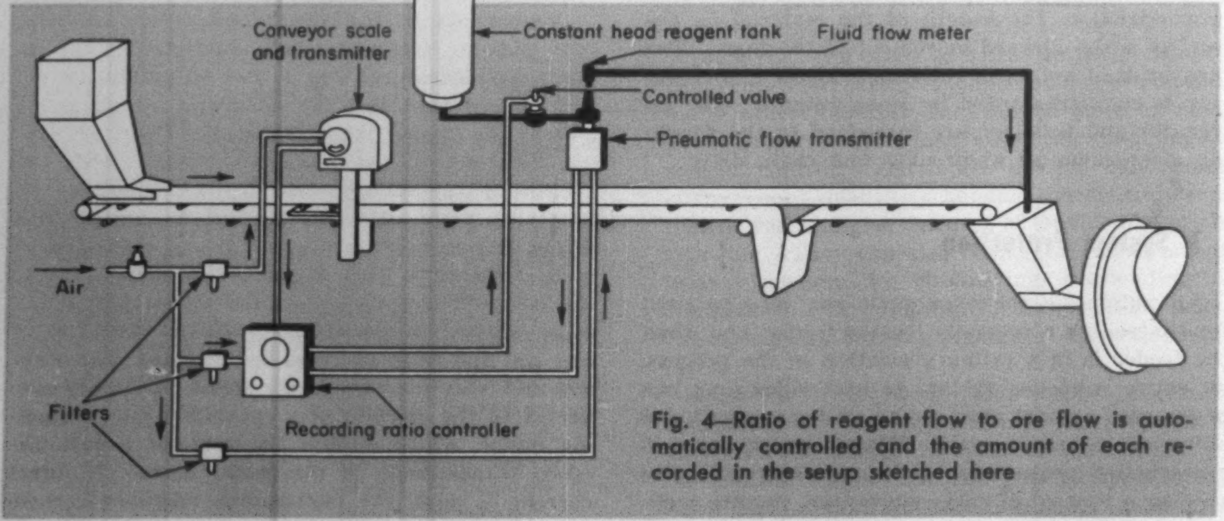

Conveyor scale and transmitter
Constant head reagent tank
Fluid flow meter
Controlled valve
Pneumatic flow transmitter
Air
Filters
Recording ratio controller

Fig. 4—Ratio of reagent flow to ore flow is automatically controlled and the amount of each recorded in the setup sketched here

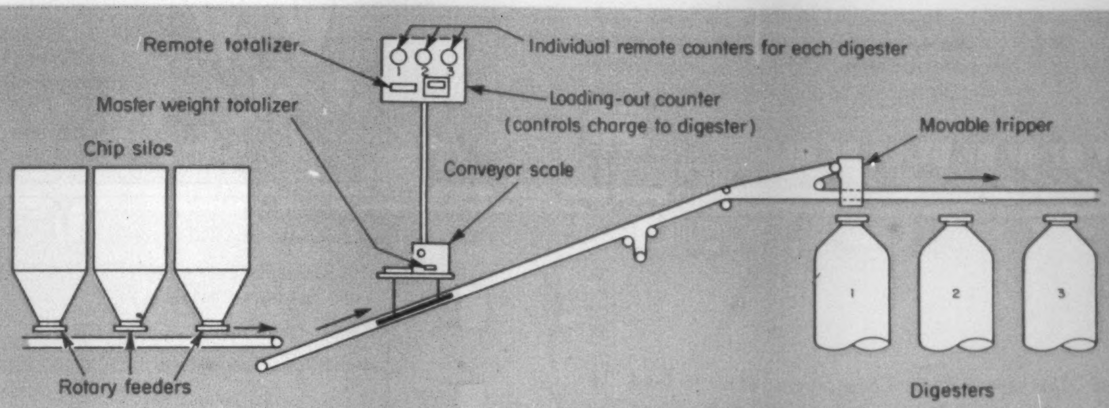

Remote totalizer
Individual remote counters for each digester
1
2
3
Master weight totalizer
Loading-out counter
(controls charge to digester)
Movable tripper
Chip silos
Conveyor scale
Rotary feeders
1
2
3
Digesters

Fig. 5—Individual weight of chips delivered to each digester as well as total weight of all chips handled is recorded by a single conveyor scale in this installation

Courtesy, Merrick Scale Mfg. Co.

terial will be emptied from the belt before it stops. The counter automatically resets itself for the next charge.

Another use of automatic weight control is found in the beet sugar industry, where a scale provides continuous weighing of sliced sugar beets, automatic control of water, and automatic control of the speed of beet slicing machines. In *Fig.* 6 is a diagram of this application. Troughed belt conveyors from 36 inches to 48 inches in width handle up to 3000 tons of cossettes (sliced beets) in 24 hours. To meet this capacity, the scale was designed to handle 180 tons per hour, and the dial of the pneumatic position transmitter was graduated accordingly. The top of the transmitter scale corresponds to 15 psi control pressure, and the deflection of the link connecting the transmitter to the scale is figured at 1.25 inch for 180 tons per hour. This same type of installation can control the ratio of acid feed to the feed of phosphate rock in the production of phosphate fertilizer, and can control the rate of reaction in continuous dissolving tanks.

Fig. 7 illustrates ratio control of admix iron ore and sand to primary limestone. Several grades of limestone are mixed volumetrically for lime content adjustment and then weighed. The material passes over the scale on a 24-inch troughed belt conveyor, at a load rate varying between 70 and 200 tons per hour. From time to time during a normal operating day, the rate drops to 35 tons per hour, though for only 10 per cent of the operating time. Normal variation in belt load is within 10 per cent.

A pneumatic position transmitter is built into the control panel, and is calibrated to transmit 15 psi for 200 tons per hour. The proportional air pressure established by the transmitter is fed to separate feeder drive controls. In this operation, the basic ratio of ore and sand to limestone is 12 tons per hour of ore and 2 tons per hour of sand to 200 tons per hour of limestone.

Conveyoflo Meters by Builders-Providence Inc. are also of the continuously totalizing type, to which may be added a rate-of-delivery control for accurate, gravimetric feeding. They too can serve as control instruments in dry material blending by

Courtesy, Merrick Scale Mfg. Co.

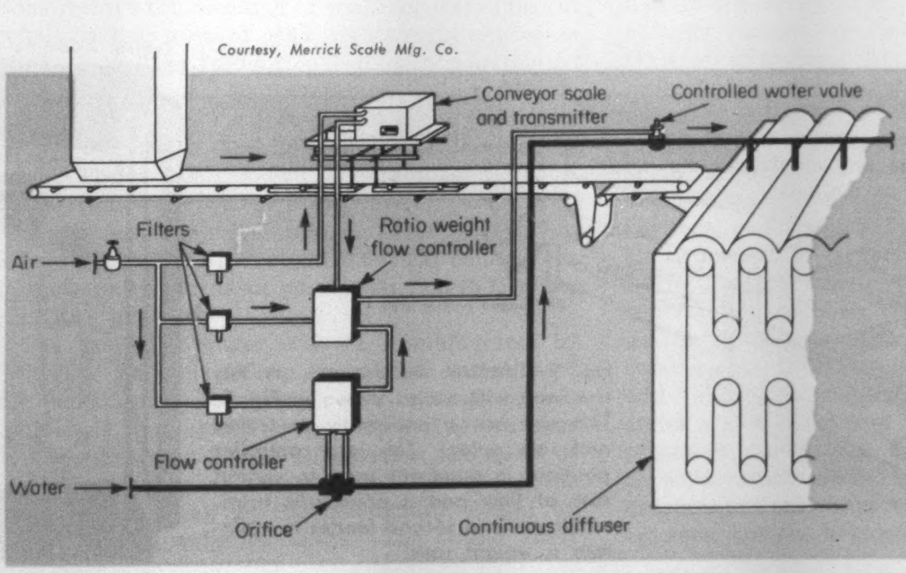

Conveyor scale
and transmitter
Controlled water valve
Filters
Ratio weight
flow controller
Air
Flow controller
Water
Orifice
Continuous diffuser

Fig. 6—Ratio control of water and sugar beet cossettes (sliced sugar beets) going into a continuous diffuser can be maintained over a range of flow rates as shown

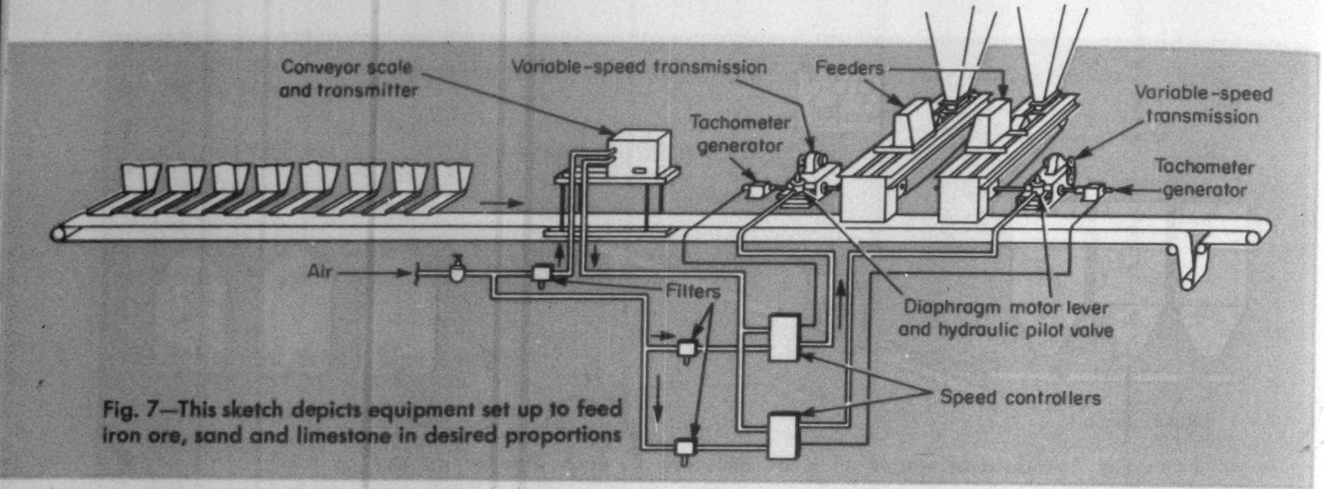

Conveyor scale and transmitter
Variable-speed transmission
Feeders
Tachometer generator
Variable-speed transmission
Tachometer generator
Air
Filters
Diaphragm motor lever and hydraulic pilot valve
Speed controllers

Fig. 7—This sketch depicts equipment set up to feed iron ore, sand and limestone in desired proportions

Courtesy, Merrick Scale Mfg. Co.

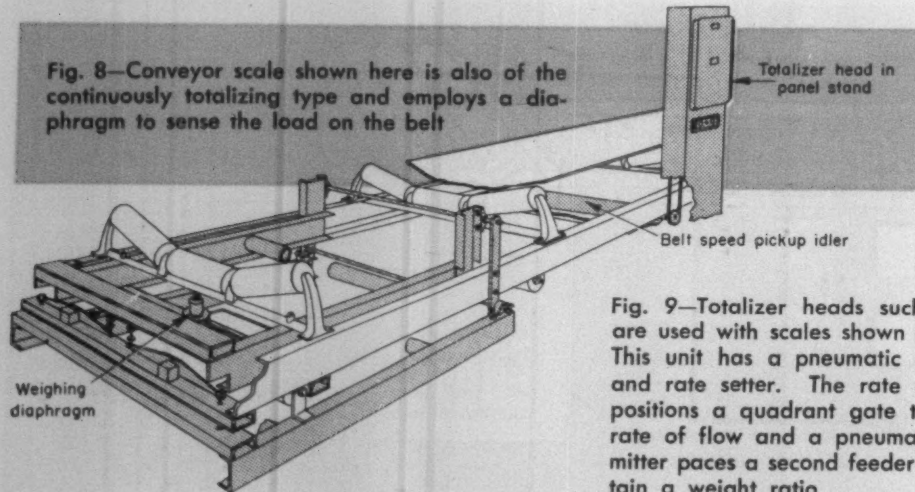
installing an air pressure transmitter to pace the discharge of material from various sources. *Figs.* 8 and 9 illustrate typical equipment. The weighspans which respond to the load are supported at one end by self-aligning ball-bearing pillow blocks, and at the other end by the return-belt weighing levers and a direct-action sensitive diaphragm. This diaphragm is pneumatic, largely insensitive to temperature change, and its stem has practically no permanent deflection under varying load. The entire mechanism operates mechanically and pneumatically, with no electrical connections required on standard models.

Variations in belt load are transmitted via the diaphragm, variations in belt speed are transmitted through a chain-and-sprocket drive, and the two factors are multiplied to obtain the total weight. The totalizer consists of an integrating wheel and disk, similar to those of other continuously totalizing conveyor scales which have been described.

The pneumatic linkages are very accurate and sensitive. The air pressure from the diaphragm is led into a pressure-responsive element which is linked to the flapper of a flapper-nozzle air controller. This is a positive positioning device, and sensitivity is maintained because only a negligible load is imposed on the pressure-responsive element. Input air pressure is reduced to 20 psi and fed into a nozzle system. This in turn activates a booster valve which amplifies changes in the nozzle pressure and which can control larger volumes of air. Full range of integration is obtained with pressure changes of less than 2 psi, and very small fluctuation in flapper-nozzle aperture. Thus the system is not only sensitive but capable of rapid response to minute variations in belt loading.

Output pressure from the booster valve acts on a power cylinder, and forces a piston against a return spring connected to the integrating wheel. Mechanical measurement of belt travel and pneumatic response to belt load are combined in a design with minimum inertia and time lag, and maximum sensitivity. The slight changes in belt tension that are normal to conveyor systems have virtually no effect on accuracy, because sustained deflection of the weighing diaphragm stem is less than 0.005-inch from zero to full load. This machine is stated to be dependably accurate within plus or minus $1/2$ of 1 per cent of actual weight from

Fig. 8—Conveyor scale shown here is also of the continuously totalizing type and employs a diaphragm to sense the load on the belt



Courtesy, Builders-Providence Inc.

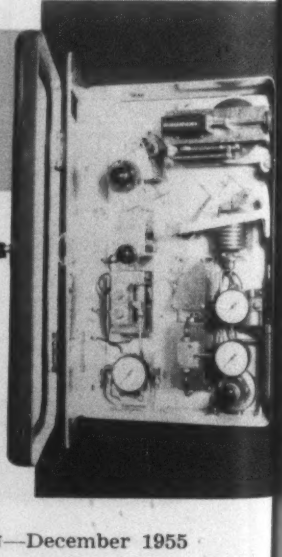
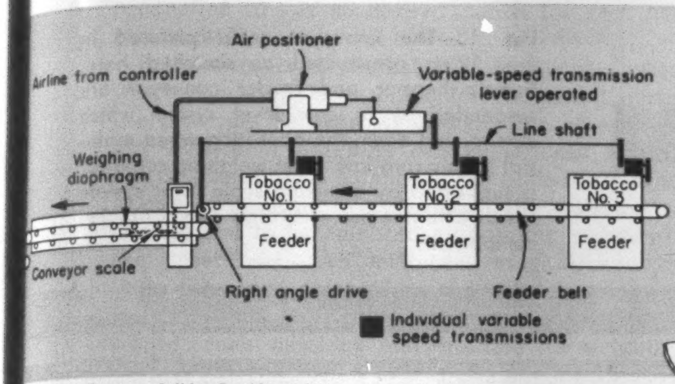


Fig. 9—Totalizer heads such as this are used with scales shown in *Fig.* 8. This unit has a pneumatic controller and rate setter. The rate controller positions a quadrant gate to control rate of flow and a pneumatic transmitter paces a second feeder to maintain a weight ratio



Courtesy, Builders-Providence Inc.

Fig. 10—This system for control of three components in a tobacco blend allows changing of blend proportions and also variation in blended total without change of proportions

Courtesy, Sintering Machinery Corp.

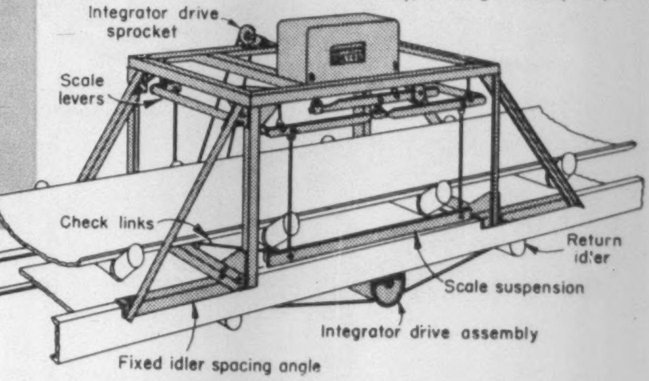

Integrator drive sprocket
Scale levers
Check links
Return idler
Scale suspension
Integrator drive assembly
Fixed idler spacing angle

Fig. 11—Automatic continuously totalizing conveyor scale shown employs a mechanical gear differential as integrator and requires no electric or pneumatic connections

100 to 50 per cent of rated capacity; within plus or minus 1 per cent of actual weight from 50 to 25 per cent of rated capacity; and within plus or minus 2 per cent of actual weight from 25 to 10 per cent of rated capacity. Flow of materials as light as tobacco or as heavy as coal can be controlled with a Conveyoflo. When different tobaccos are blended, the amounts from the different bins must be weighed, and the flow must be instantly adjustable to accommodate changing factory conditions without disturbing the proportions. Automatic weight control of a three-component tobacco blend in shown in *Fig.* 10. A pneumatic controller with a manually adjustable rate setter regulates a variable-speed transmission, which drives the main conveyor belt into the factory and each of the three ingredient feeders through individual variable-speed transmissions. A predetermined rate of delivery of blended tobacco can be maintained, and changes in the blend can be made simply by altering the settings of three individual feeder transmissions. Once the blend is set, rate of flow into the manufacturing area of the factory is instantly adjustable by a single operator, via the knob on the calibrated rate setter.

Accuracy is also obtainable in blending high tonnages of heavy material, and typical applications include the blending of coals for metallurgical coke, feeding cement and lightweight-aggregate kilns, as well as feeding coke to gas manufacturing plants and coal to powerhouse boilers. Weighing accuracy is not affected by angle or direction of belt inclination, and belts of any width may be used. The standard Conveyoflo requires no overhead framework or external lever system, and lateral space required for the totalizer head is less than 12 inches. Absence of electrical connections in these units can mean great reduction in fire and explosion hazard.

The Transportometer, *Fig.* 11, manufactured by Sintering Machinery Corp., is another variation of the continuously totalizing conveyor scale, and is completely mechanical in operation. The conveyor belt integrator is a gear differential; the speed of one side varying as the conveyor belt speed, the other side varying as the momentary weight on the suspended weighing idlers. The output shaft is geared directly to the tonnage totalizer. Compensation for light and heavy sections of the conveyor belt is made automatically and continuously, and a double weighing suspension is not required.

Two (and sometimes three) conveyor idlers float free from the conveyor frame and are supported by the scale system. The scale mechanism is completely free-floating. Flat steel strips hang edgewise from the lever system at four points to support the weighing idlers and prevent them from binding against the frame or the conveyor. Failure of the regulating means does not destroy the record, because the scale lever system is separated from the regulators.

Even if the control mechanism is removed, the machine will accurately weigh and record the material being moved. In case of an interruption in material supply, the totalizer does not operate; and if the empty belt continues to run, no erroneous records are made. Use of a complete scale lever system, rather than a balanced beam controlled by preregulated feed, eliminates errors due to time lag in rebalancing the beam after feed interruption. This is essential for maintaining a preset contant feed rate for blending, or for even distribution to other processes. To maintain proportions, material density changes are compensated for by automatic variation of belt speed.

The Transportometer is often used in solid-liquid separations, such as canning and other food-industry waste disposal, and municipal sewage processing. In these cases, solid material is mixed with, and often suspended in, volumetrically measured water. Settling out, screening and other processes remove the filter cake and other solid deposits, which usually require weighing. The records are not only economically necessary to the operations, but are in most cases vital data for deter-

Courtesy, Richardson Scale Co.

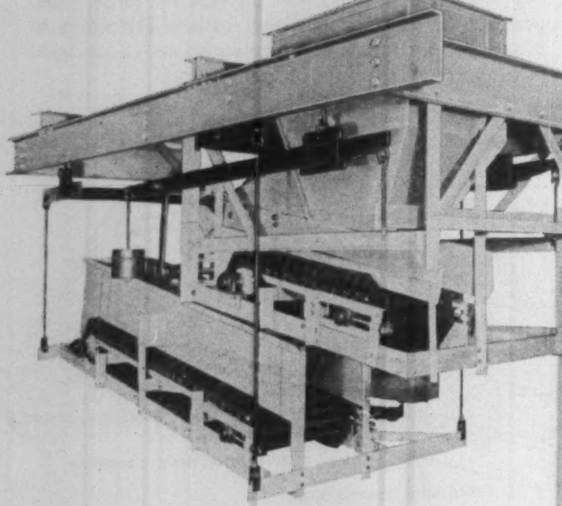
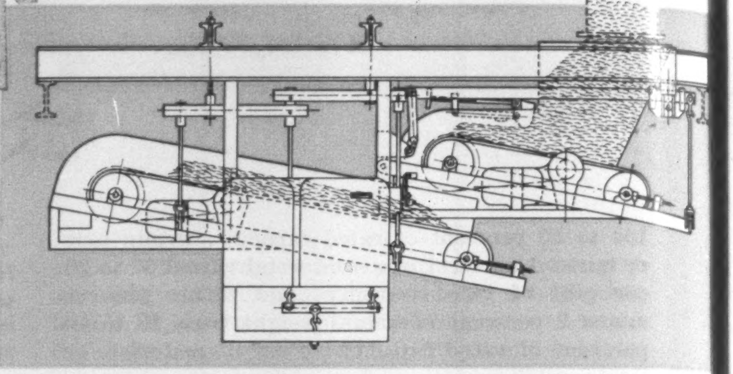


Fig. 12—Intermittent type conveyor scales such as shown here actually weigh separate batches of material in rapid succession. Instead of rubber belt conveyors, this particular unit is equipped with interlocking plate conveyors for use with hot materials

Fig. 13—The conveyor scale pictured i *Fig.* 12 is constructed as sketched here Supply hopper and feeder conveyor ar suspended by a scale lever system whic acts to shut down the operation when material supply runs low. The weighing conveyo is supported by a second scale lever systen which actuates the recording and totalizin components



mining future requirements. Moreover, if the solid residue is sold for fertilizer or other uses, double handling for reweighing is eliminated.

▶ Intermittent Conveyor Scales

The Convey-o-Weigh, *Figs.* 12, 13 and 14, built by Richardson Scale Co., is a combined automatic scale and conveyor of the intermittent type. It is essentially a rapid-sequence batch weigher, which weighs definitely separated preset quantities of loose material fast enough to afford virtually continuous flow. Capacities of different models range from 250 pounds to 250 tons per hour, and thus they are not used to weigh the extremely high tonnages which pass continuously over mine, quarry, and smelter conveying systems. On the other hand, their construction permits instantaneous testing during the intervals between batches, an advantage over the conveyor scales previously described. Continuously totalizing conveyor scales are capable of equally accurate testing by means of test chains, but this cannot be done while the machines are operating in production. Both types weigh within an accuracy of 99½ per cent.

A Convey-o-Weigh scale consists of a structural steel frame, feed hopper, and motor driven feed unit; a system of scale levers; and a weighing conveyor. The feeder conveyor and weighing conveyor are independently driven, and the weighing conveyor is hung from the scale levers. The weighing controls consist of the familiar graduated scale beam with weights and sliding poises, a load register, and electrical controls. When the feeder conveyor discharges a preset amount onto the weighing conveyor, the scale beam rises and activates a mercury switch. This in turn opens the circuit to the motor of the feed conveyor, which stops, and thereby cuts off the supply of material. There is thus a weighed and recorded batch of material on the weighing conveyor, and after a certain amount of each batch has been discharged (to processing machines, a conveyor line, or storage facilities) the weighted end of the scale beam descends; closing the mercury switch of the feed-conveyor motor, and starting the feed conveyor again. Standard arrangements provide for intermittent operation of the feed conveyor and continuous operation of the weighing conveyor. Two to three complete, discrete weighings per minute is the usual cycle.

The Convey-o-Weigh functions well as an automatic quantity control instrument by virtue of its variable-feed control and self-testing switch. The feeder unit (hopper and feed conveyor) is mounted on its own scale lever system. This, in turn, hangs from the main frame and is connected to a balanced toggle mechanism. The variable-feed control hopper will not run empty while the machine is operating, because counterweights close the toggle mechanism, tip a mercury switch and stop the machine. Interlocked controls can also stop all other conveyors and processing machines that would be affected by material shortage or failure of supply. Material for at least one complete batch will remain in the feed hopper, to insure smooth and accurate resumption of the process.

Material supply is controlled in the following way. When the feed hopper is filled, the pivoted feeder descends until it comes to a full stop. The weight of the load, combined with the action of the toggles, holds the feeder in its operating position. When material supply is depleted to a critical level, the feeder moves forward, opens the control switch, and stops the machine (or entire production line if so desired) until the feed hopper is refilled.

Self-testing is accomplished by means of a switch which can stop the machine for an instant during the intervals between weighing. The accuracy of any individual weighing can be checked immediately by noting the balance of the scale beam, when a load of material on one end of the scale system is supposed to be balanced by hanging weights on the other end. All switches, weights, and the scale beam are enclosed in the same housing, together with a six-figure continuous counter which records each weighing and totalizes the weighings made. Alternative recording devices include such a counter combined with a setback ticket printing counter.

Many types of materials can be weighed and transported by these units, and there are numerous variations to meet specific needs. For cool materials, both conveyors are equipped with rubber belts. For hot materials, and where abrasion is high, steel apron conveyors are furnished. These latter applications include feeding warm cement clinker from coolers to storage; moving hot lime from kilns; and controlling the feed of burnt clay to mixers, and phosphate rock to kilns. These devices afford accurate process control for feeding lime to soda liquor tanks and slaking tanks, and control the intake of coke and coal to kilns and furnaces where careful temperature control is required. For damp materials that are heavy and lumpy, the feeder uses a steel apron and the weighing conveyor has a rubber belt. With exceptionally dusty material, or where high abrasion demands a minimum of moving parts, the rubber or steel weighing conveyor is replaced by a steel apron feeder and a revolving weighing hopper.

Courtesy, Richardson Scale Co.

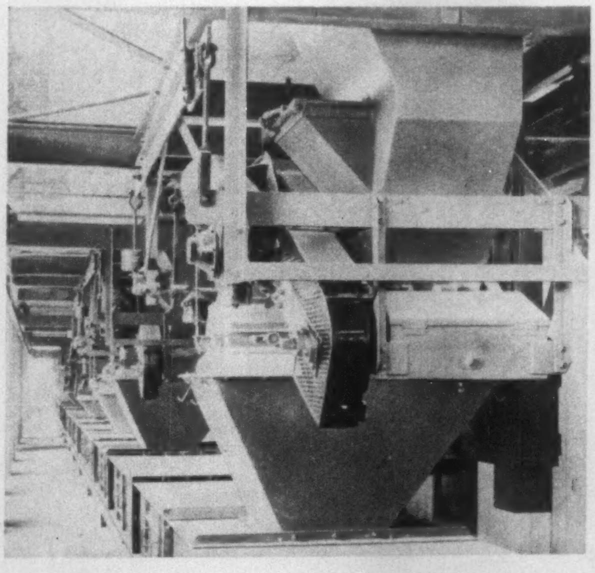
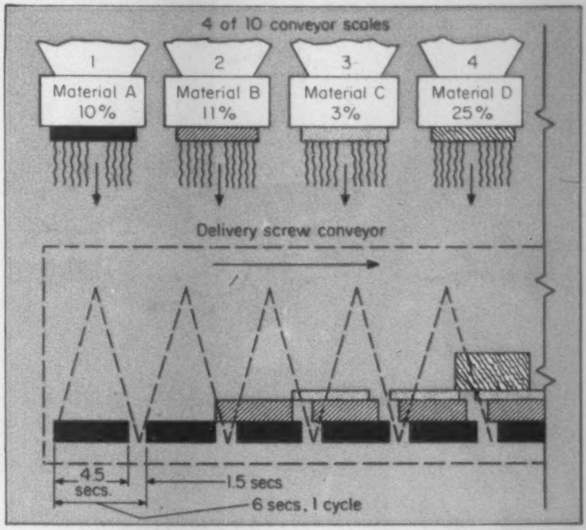


Fig. 14—Installation pictured is in a glass-making plant using enclosed conveyor scales to control feed rates and proportions of raw materials



Courtesy, Richardson Scale Co.

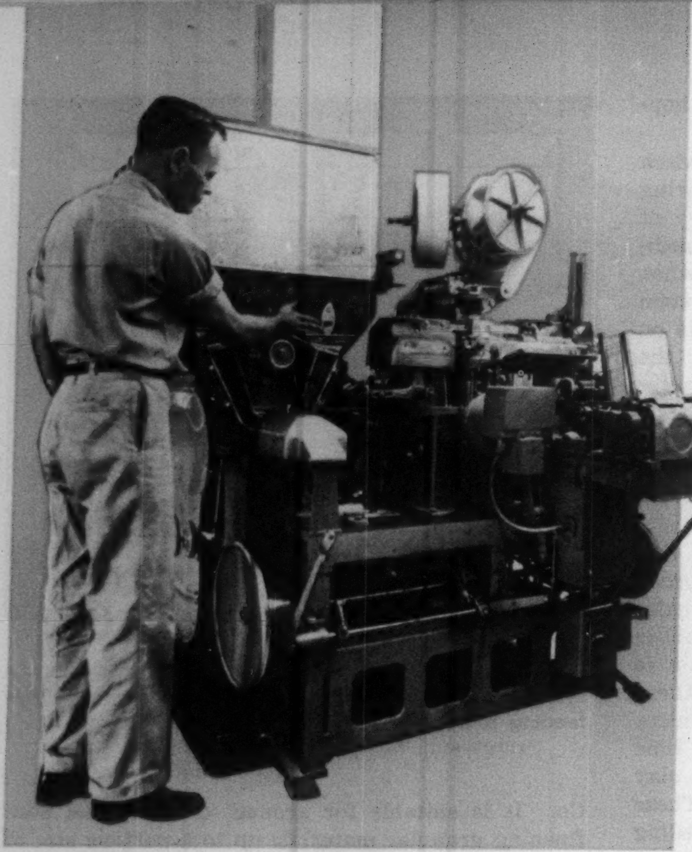
Fig. 15—Sketch portrays mixing action and cycling in system of several intermittent type conveyor scales feeding a single screw conveyor

The Conveyometer is a similar device of the intermittent type supplied by Richardson Scale Co. It is suitable for ground, crushed, and nonflushing granular materials up to a particle size of 1½ inches. Such materials include practically all mineral and chemical products, as well as grain, feed, and seed, tankage and fertilizers. This device also uses an actual scale lever system to weigh prescribed masses of material in distinct increments, unaffected by angle of repose, variations in belt speed or belt tension, or skirt-board friction. The batch-weighing cycle is repeated several times each minute, rapidly enough to afford continuous flow for all practical purposes. Two conveyor belts are utilized; a gear-driven feed belt which divides the material into batches of nearly equal volume and a weigh-belt which is suspended from the lever system. Variations in material density react on the scale beam, and a motor controlled by mercury switches changes the position of the leveling plate so as to increase or decrease the depth of material released onto the feeder belt. Automatic adjustment of the flow is made once each cycle and is signalled as follows: a white light indicates weight within tolerance; a blue light underweight and red overweight. The ensuing automatic correction is re-indicated by the white light. One advantage of this system is that intimate blending can be accomplished with a minimum of stratification. Several feeders can operate from one lineshaft, interlocked to engage and disengage in sequence during each cycle, while maintaining both the schedule and ratios of the blend. *Fig.* 15 illustrates part of a 10-cycle per minute system using 10 Conveyometers discharging into a common screw conveyor.

In a second section to follow, the author will discuss weight-control feeders, their differentiation from conveyor scales, and various types and applications of such equipment. The author is indebted to the companies who assisted in furnishing engineering data and illustrations.

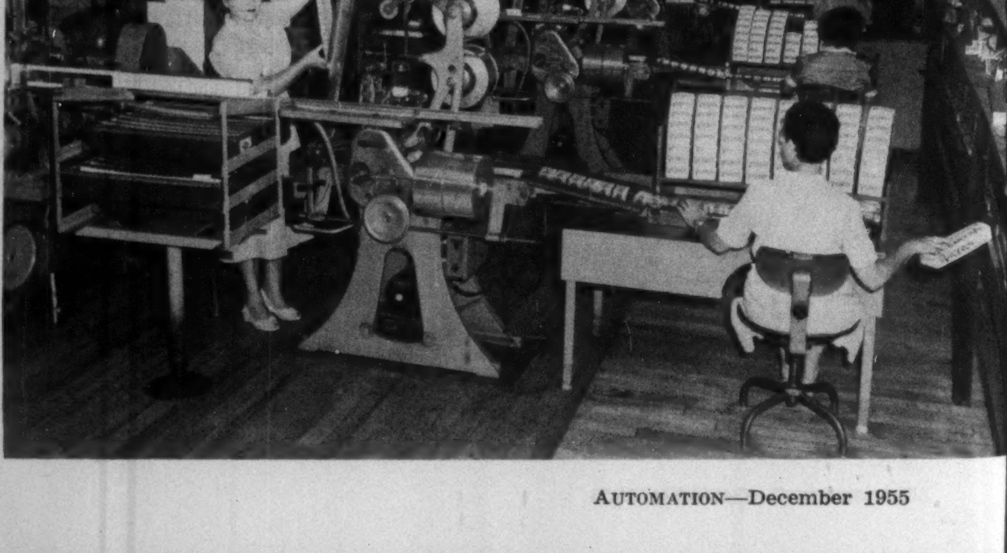
AUTOMATION
TODAY

PACKAGING CIGARETTES



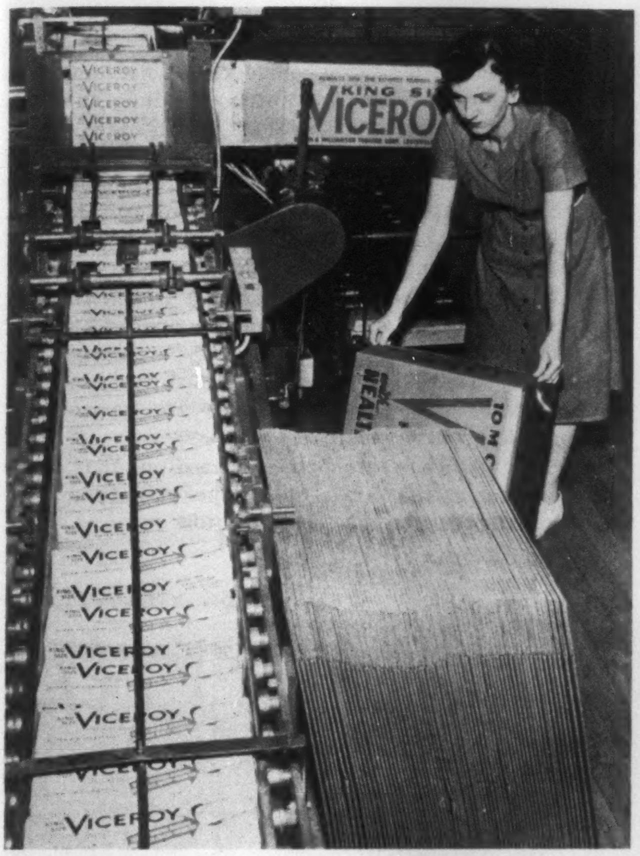
1

Automatic cigarette packing machine at Brown & Williamson Tobacco Corp. wraps 20 cigarettes in foil and paper and stamps the finished packs. A number of these machines are employed in the Viceroy line. Each machine handles 2500 cigarettes per minute, making 125 packs



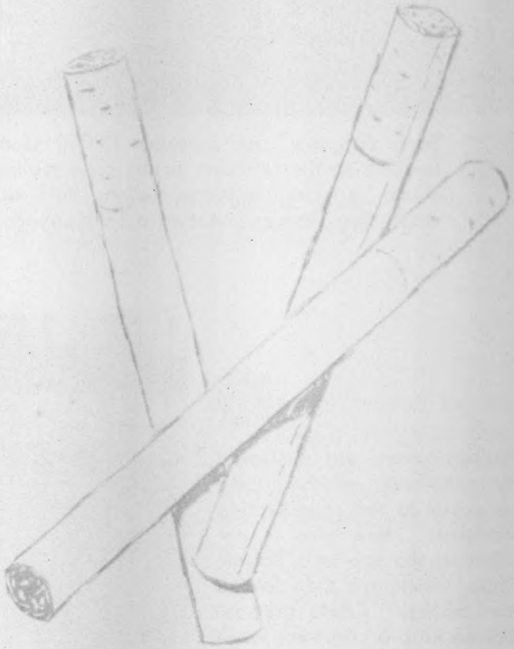
2

Used in conjunction with each packing machine is an automatic cellophane wrapping machine. The packs are delivered by this machine onto a table where they are inspected and placed into cartons. Closed 10-pack cartons are placed on a conveyor for delivery to the case packer



3

At this station on the line the operator folds the cases (which are received from Hinde & Dauch in flat form) into their box shape. Folded cases are then mounted on the packing machine



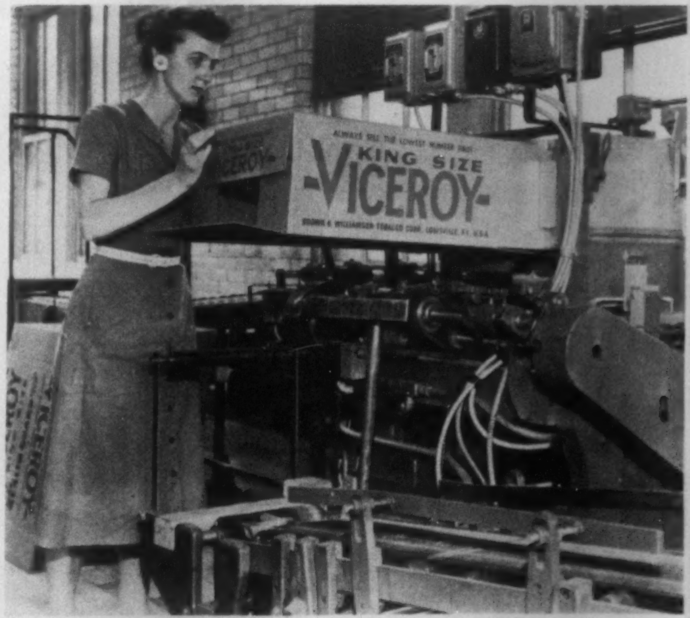
AN INTEGRATED packaging line that handles 40,000 cigarettes per minute requires strict control of quality of all materials used if the operations are to be free of costly shutdowns. The marketing and distribution system that gets the cigarette into the smoker's hand creates a need for four successive steps in establishing the final shipment units that leave the cigarette factory.

First, the cigarettes are wrapped in packs of 20 for the customer to carry in his pocket. Second, the packs are made up into cartons of 10 for the retailers stock. Third, the cartons are packed 50 to the case for wholesaler warehousing. Fourth, the cases are stacked 30 to a pallet for shipment from the factory.

Archibald Robertson Jr., Assistant Plant Manager of Brown & Williamson's Petersburg, Va. plant states that, "The strict adherence to quality control which so typifies the cigarette industry does not end with the cigarette alone." Viceroy's automatic packaging operation requires close quality control in the shipping cases as well.

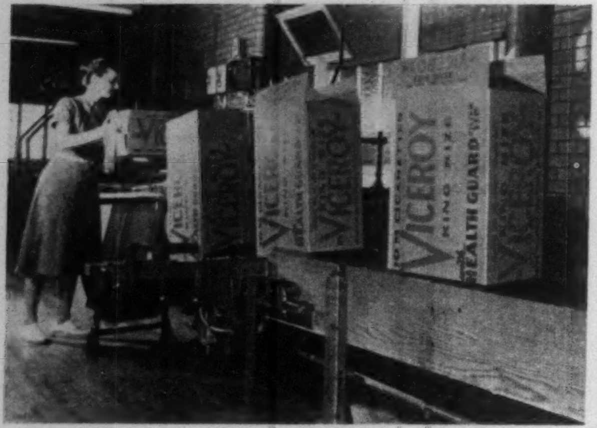
At the loading stage, for example, uniform case size is of vital importance. A slightly undersize box will jam the case packer, with obviously chaotic results. An oversized box will produce a sloppy package that neither stacks nor ships well.

End flap uniformity is another important consideration. If flaps are too long they overlap and jam



4

Precision size of the 50-carton case is important on this operation that loads 25 cartons at a time into a case. Automatic machine operates at the rate of four cases per minute



5 Each shipping case contains 10,000 cigarettes headed on the conveyor to the case sealing machine. Loaded package weighs 38½ pounds, empty box weighs one and a half pounds

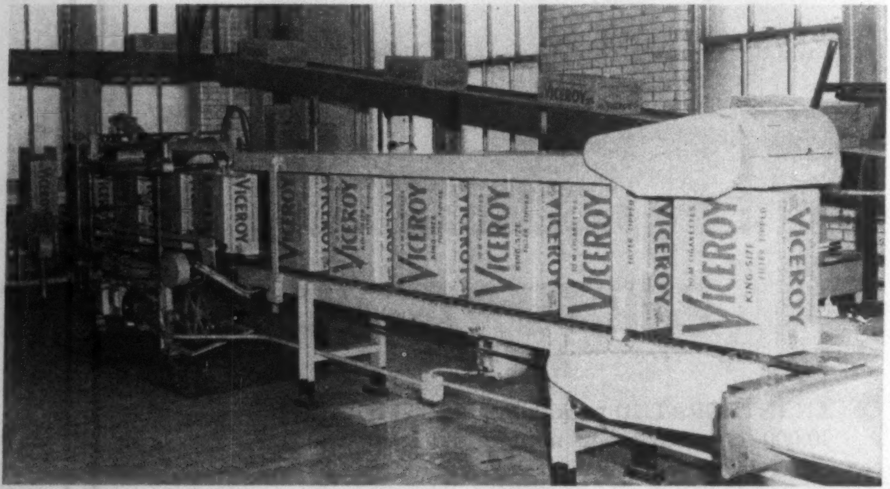
the sealing unit; yet if they are too short the cartons inside are exposed to dust.

Besides the accuracy consideration necessary for top efficiency from the automated line, the case must meet other specifications. With high volume shipments, weight is a primary consideration. The material must be soft enough to prevent slipping off pallets, hard enough to provide good protection. It must stack well and have a surface that will take the sealing glue and be receptive to printing.

The carton designed by Hinde & Dauch for this service is made of kraft, weighs one and a half pounds and is designed with *B* type fluting (end flap) rather than *A* type (side flap) because it offers more strength when boxes are horizontally stacked in warehousing.

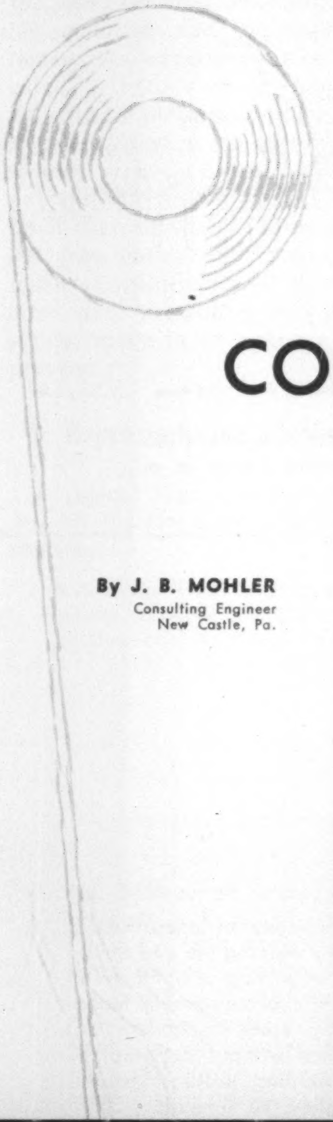
Brown & Williamson's mechanized line that packs cigarettes at the rate of 40,000 per minute is illustrated in the accompanying photos.

6 Packed cases are delivered by automatic elevator and conveyor to the case sealing machine. Here glue is applied to the top and bottom flaps, which are then folded and sealed. Cases are delivered onto a conveyor leading to the shipping department



ATSF
148067
VICEROY
KING SIZE

7 Conveyor from the case sealer delivers finished cases onto a table. At this point the cases are palletized, 30 to a pallet, from whence they are handled by fork truck into storage, or directly into freight cars or trucks



Discussion of some continuous strip processing problems and their solutions highlights the complexities which can confront an industry in developing successfully automated systems. One important conclusion stands out—co-ordination of the efforts of many industries is the key to ultimate success

CONTINUOUS PROCESSING OF STEEL STRIP

By **J. B. MOHLER**
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New Castle, Pa.

EXEMPLIFYING the evolutionary nature of automation as we know it today, the development of continuous steel strip processing lines can be attributed to no one individual or even to any single company. Some companies have been first in adopting certain practices, but the variety of solutions indicate the parallel research which preceded the various solutions to the same problems.

Development of continuous strip processing was accelerated for several reasons—the need was great; the raw product was available in coiled form; and certain basic techniques could be adopted from existing industries. Methods for rolling to produce a high finish, rolling

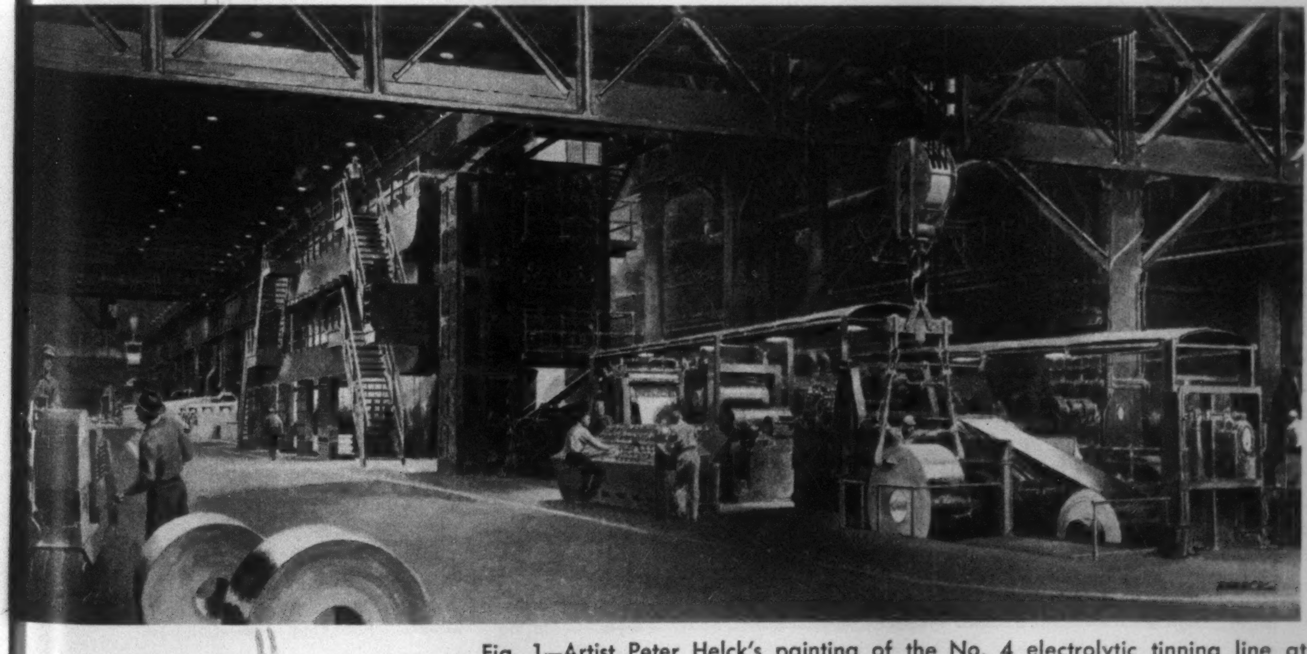


Fig. 1—Artist Peter Helck's painting of the No. 4 electrolytic tinning line at Weirton Steel Co.

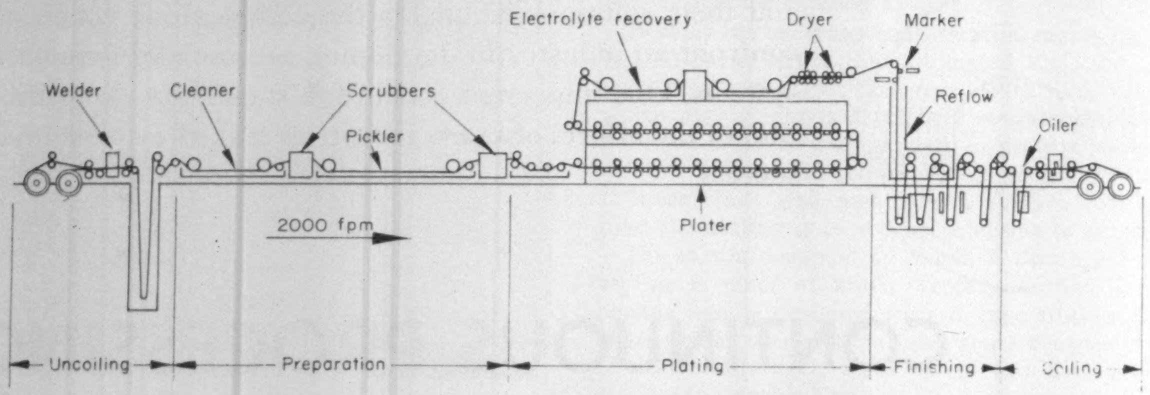

Electrolyte recovery
Dryer
Marker
Welder
Cleaner
Scrubbers
Reflow
Pickler
Oiler
2000 fpm
Plater
Uncoiling
Preparation
Plating
Finishing
Coiling

Fig. 2—Schematic diagram of same line shown in *Fig.* 1. Although the component machinery and process details can differ, this represents general sections found in all plating lines processing steel strip

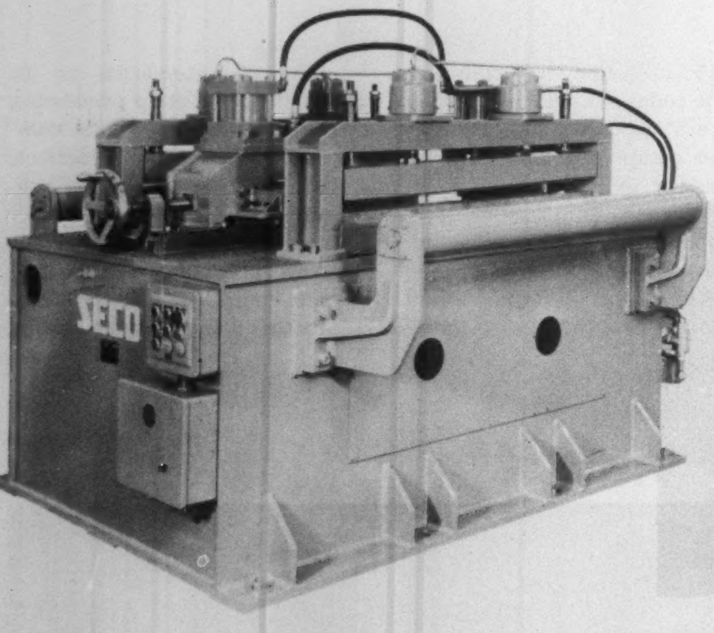
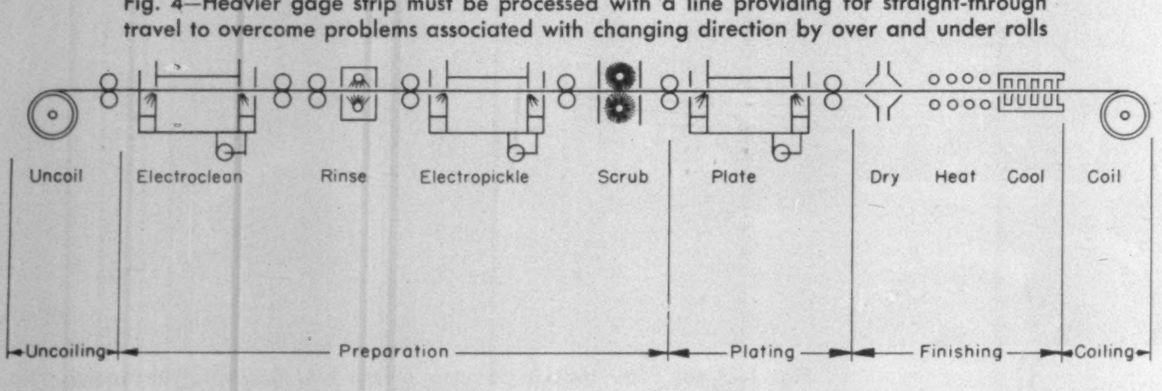


Fig. 3—Continuity of operations is achieved by welding the end of one coil to the beginning of another coil with this type of equipment manufactured by Steel Equipment Co. Accomplished without stopping the line, the welding process requires approximately 10 seconds

Fig. 4—Heavier gage strip must be processed with a line providing for straight-through travel to overcome problems associated with changing direction by over and under rolls


Uncoil
Electroclean
Rinse
Electropickle
Scrub
Plate
Dry
Heat
Cool
Coil
Uncoiling
Preparation
Plating
Finishing
Coiling

to close tolerances, annealing, heat treating, polishing, painting and hot-dipping were already perfected. As experience was gained, more complicated methods were developed to produce bi-metallic strip by plating, cladding, casting and sintering, *Fig.* 1. These more complicated lines contain numerous steps and are individually constructed by putting together a variety of equipment to perform each of the required operations in the process; the entire line is co-ordinated by electrical means. Consideration of one of these later forms of steel strip processing will illustrate the technical strides made in obtaining a continuous automated process.

▶ Representative Plating Line

A typical high speed electroplating line, *Fig.* 2, can be conveniently subdivided into these main sections:

1. Uncoiling—beginning of a continuous operation where coils are introduced into the line. In this section can be found coil holders, pinch rolls, shears, welders and some means of establishing slack in the strip ahead of the preparation section.
2. Preparation—area in which metal strip is prepared for plating operation. Equipment consists of various combinations of items such as cleaning tanks, scrubbers, pickle tanks and rinse means.
3. Plating—area in which an electric current is passed through the strip as it travels through an electrolyte in the presence of an electrode of the plating material.
4. Finishing—electrochemically deposited surface is not always suitable for the commercial use for which the product is intended. In the finishing area the surface can be fused by heat, brushed or treated chemically to bring product up to standard.
5. Coiling or shearing and piling—at the exit end of the line, the finished plate is recoiled or cut into suitable sizes and piled in preparation for packaging.

There are many variables involved in determining the final character of a continuous line. For instance, the length of the line will be determined by the strip speed and the required time in each of the processing steps. Electrocleaning may be done anodically, cathodically or both; pickling may be partially chemical and partially electrochemical; scrubbing may or may not be necessary; plating may be with an acid bath or an alkaline bath; and flow brightening by means of heat may be done by several different methods. The history of the steel strip being used can influence the process. Prior rolling, tempering and oiling of the strip may determine the type of cleaning and pickling required. Strip may be processed at a few feet per minute or at several thousand feet per minute and it may be treated in multiple or single strands.

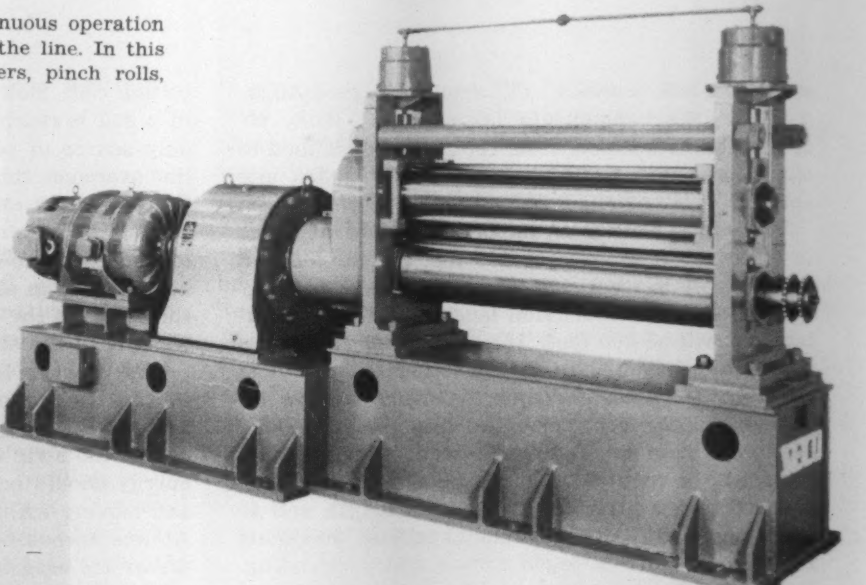


Fig. 5—Required tension is achieved with use of unit similar to this manufactured by Steel Equipment Co. which acts as either motor or generator. When applying drag through generator action, excess current is fed into bus driving other motors

Whatever the details, the entire process can be highly automated and can be considered as a continuous operation. In larger lines, the beginning of one coil of unplated strip is automatically welded to the end of the completed coil to form a continuous unbroken strip of steel, *Fig.* 3. It is also possible to develop a self threading line and to feed a new coil into a line as the previous ones leave. Thus the process may be continuous even though the coils are not welded end to end. Also, in a slow line it can take several hours to pass a coil so that the operation is continuous for all practical purposes.

Certain problems are common to these continuous lines. If the line contains enough steps, the power required to convey the strip will be sufficient to tear the strip and to damage the line if the

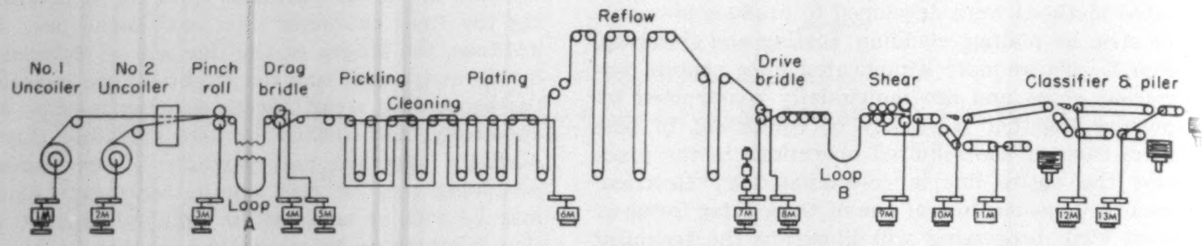


Fig. 6—Simplified flow and control diagram of electrotinning line engineered by The Clark Controller Co. Control of this line is obtained through three regulators: line speed, plating and heating. Plating and heating regulators control current relative to selected speed set on line speed regulator

strip becomes jammed. Consequently, good alignment of the components is required. Also, co-ordination or compensation for factors that tend to change the speed of the strip must be taken into account.

Processing time is an important factor. If a line is to travel at a speed of 400 feet per minute and an electrolytic treatment time of 15 seconds is required, then the immersion length for this particular step will be 100 feet. If a number of such steps are required then the line will either be quite long or multiple passes through the tanks will be required. For the electrochemical treatment of a long section, a number of direct current electrical contacts will be required. This is necessary to get the current to the strip throughout its length and to keep the quantity of current at a safe maximum for each contact to avoid arcing and overheating. Because of these limitations it is necessary to bring the strip out of the solution at a number of points to make contact.

▶ Tension Influences Design

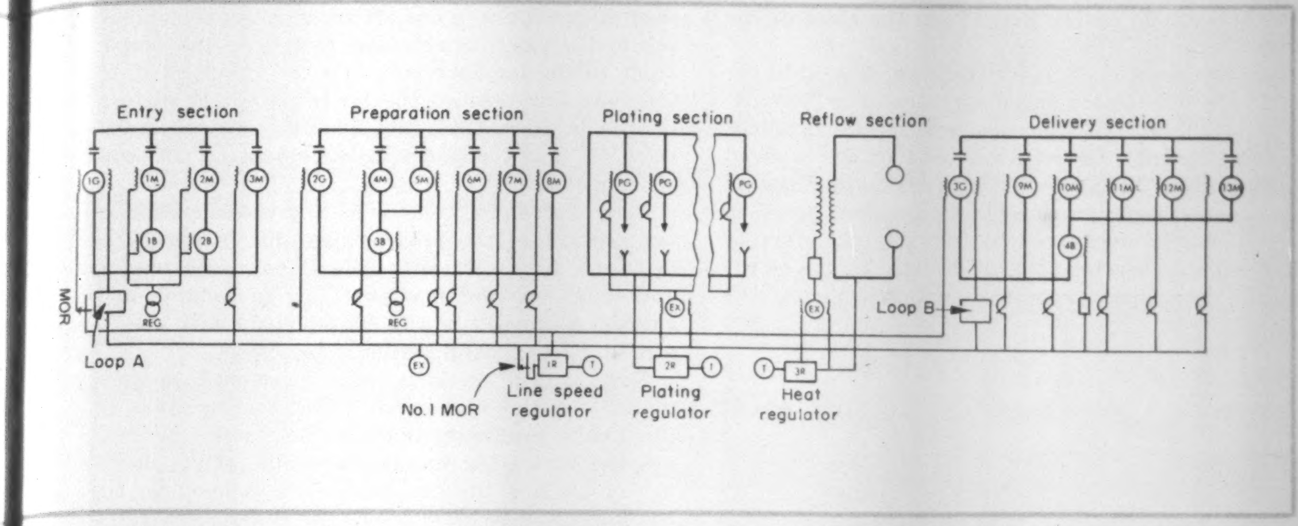
For heavy strip, changes in direction over and under rolls increase the power requirements to convey the strip. A strip $\frac{1}{8}$-inch thick will require a minimum number of direction changes and large diameter rolls where direction changes are needed. The commercial limit for coiled steel strips is about 0.150-inch in thickness. Heavier strips are handled as slabs which can be automatically fed to power rolls and continuously passed into a series of constant-feed pinch rolls and thus passed through the line.

It can be seen that it is not only desirable but necessary to design for straight-through travel for heavy-gage strip. A schematic line for slow-speed electrotinning of heavy strip is shown in *Fig.* 4. If the resistance to travel is not great the strip may be pulled through the line by means of a powered coiling roll. However, if the strip is cut or the end of a coil is reached, the line will stop if this is the only source of power. Power rolls throughout the line overcome this. If multiple power rolls are used, then a welder and a shear may be added for continuous processing. The speed of such rolls must of course be co-ordinated and compensation must be made, as in all cases, for changing the speed of the coiler as the diameter of the coil increases with winding of the strip.

The problem of maintaining pull, drag or slack in a moving strip really consists of determining the amount of energy to put into the strip or to take out of the strip at each point in the line. Enough energy should be put into the strip to keep it taut and moving within the elastic limit of the material. At line speeds up to 1000 feet per minute, helper drives are used to just overcome the friction of the rolls to keep the strip moving and in line. Such drives may be required for the conductor rolls used for putting current into the strip or for hold-down rolls to take the strip beneath the surface of a solution. A number of these drives may be belt or chain driven from a single motor. At higher speeds of 1500 to 2500 feet per minute it becomes more necessary to drive each roll with a separate dc motor.

Precision tension units are used at various points on a line to maintain predetermined tension. Throughout a plating line the tension is maintained through motor speed variation in response to the bus current supplied by a variable-voltage generator. For drag, a unit may be used that will act both as a motor and a generator, *Fig.* 5. As a motor it can feed a coil into position for welding. As a drag unit it can act as a generator, putting back tension into the strip and feeding current into the bus for driving the other motors.

A line section may be operated with a tension unit, driving and helping rolls, and a drag unit—all operating from the same generator so that speed co-ordination can all be related to one piece



of rotating electrical equipment for a particular section.

▶ Control of High Speed Lines

A diagram of a high-speed electrotinning line and control circuit is shown in *Fig.* 6. For complex production lines of this type, automatic control is essential to obtain high production rates. The line of *Fig.* 4 is relatively simple as compared to that of *Fig.* 6, yet a great deal of experience is common to the two lines. The basic experience comes from the steel industry where continuous lines are used for hot rolling, cold rolling, annealing, pickling, tempering, cleaning, scrubbing, stretcher leveling, cutting, slitting, trimming and sorting. This backlog of experience was used as a basis for design of the more complex lines for continuous tinning and galvanizing.

The use of looping pits is an interesting concept in co-ordinating the various sections of a high-speed line. For instance, in order to allow stock for welding time, the line of *Fig.* 2 contains a looping pit between the coiling and the cleaning sections. The line of *Fig.* 6 contains two looping pits so that it may be divided into an entry section, a processing section, and a finishing section. Thus a single line may have sections running at three different speeds or one or more sections stopped for short periods of time. When all parts of a line are operating at the same speed, the various driving motors must operate at a proper speed relationship to maintain the loops. Various controls and safety devices can be incorporated at the looping points to insure continuous safe operations, *Fig.* 7.

Direct-current generators or rectifiers are used as a source of current for electrolytic plating, cleaning and pickling. A plating cell for the line of *Fig.* 2 is shown in *Fig.* 8. The tin is deposited on one side of the strip in one section of the line and on the other side in an upper section so that metal is always deposited on the bottom of the moving strip. Cell construction and troubles with dirt and sludge settling on the upper surface are greatly simplified by this practice. For the line in *Fig.* 2, a plating current of 80,000 amperes is available for each side of the strip. This current, along with that for the reflow unit and for flow-brightening in the finishing section, can be controlled automatically as the speed of the strip changes. It is possible to deposit metal on both sides of the strip and this is commonly done with narrower strip and at slower speeds. Also, the strip can be conveyed through units on edge or vertically

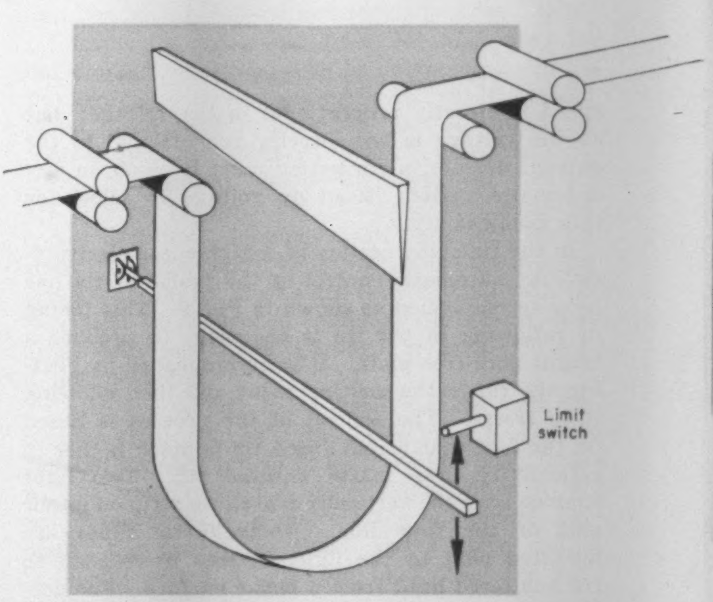


Fig. 7—Proper slack in looping pit ahead of preparation section is maintained through motor controls. In event of malfunction, a simple device operates limit switch to shut down processing line if loop becomes too short; tapered knife will shear strip if all other controls fail

so that anodes can be hung from the sides of the tank.

As was mentioned, current can be related to the strip speed to obtain automatic control of the coating thickness. The thickness is proportional to the current density for a given time or for a fixed tank length; therefore the current density should be changed in proportion to a speed change. Strip speed can be measured by the use of a speed-indicating generator coupled directly to one of the rolls. For this commonly used instrument, the speed is directly proportional to the voltage; but as the voltage is not directly proportional to the current density, a correction must be made in any automatic system based on voltage to allow for this nonlinearity.

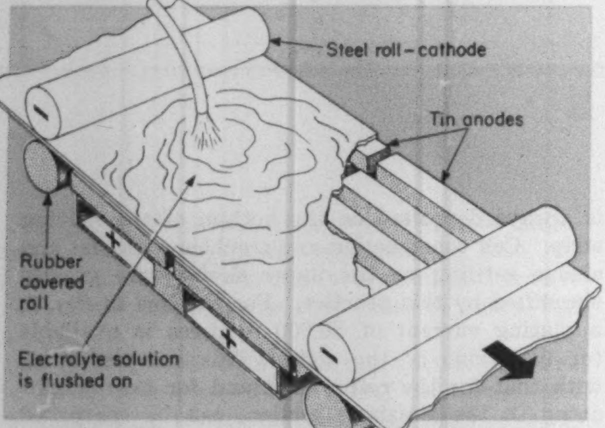


Fig. 8—Typical plating cell in which tin is deposited on underside of the steel strip. Current passes through plating solution from bars of tin (anodes) to steel strip (cathodes). On one commonly used type of tin plate, the coating of tin averages only 0.000015 inch in thickness

In the finishing section of a high-speed electrolytic line, automatic control of the fusion of tin has been accomplished as shown in *Fig.* 9. This fusing or reflowing of the tin is necessary to produce a bright pore-free plate. It is accomplished by heating the tin to the melting point and then allowing it to freeze. The control of the process is based on the fact that bright fused tin is much higher in reflectivity than matte unfused tin. Two light sources scan the vertically travelling strip on either side of the flow line. Photoelectric tubes are mounted next to the light sources to respond to the scattered light from a matte surface. For normal operation diffuse light reaches the upper photocell but the beamed reflected light on the other side of the flow line does not reach the lower photocell. If the flow line reaches the upper cell due to any change in speed, voltage or strip thickness, then diffuse light is cut off from the upper photocell and a relay is actuated to reduce the power input to the inductor coil. On the other hand, if the flow line reaches the lower photocell, diffuse light will cause the lower photocell to actuate a relay so that the power to the inductor coil will be increased.

Fully automatic control of a processing line is not possible at the present time due to unrelated factors. However, with occasional adjustments and a few manual manipulations in welding and cutting, a line can be run continuously with operators at a few control stations, *Fig.* 10.

New control methods were developed in particular for the high-speed electrotinning lines in the 1930's and many improvements were put into practice during the war years because of the shortage of tin and the fact that more economical tin coatings could be produced by the electrolytic methods than by the previous hot-dip methods. Electrical problems which required study involved equipment used to drive rolls and handling equipment, electric current for depositing tin, and electric power for flow brightening.

Motors to drive uncoilers, rolls and reels must be operated to maintain speed and tension in the cleaning, pickling, plating and brightening units. Motors driving uncoilers and winding reels must

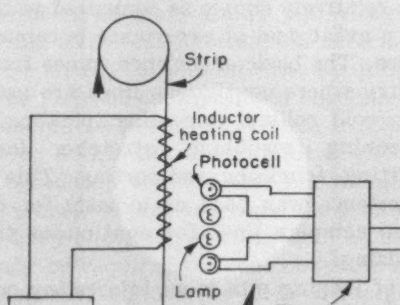


Fig. 9—To obtain bright, nonporous surface it is necessary to raise the temperature of the tin to the melting point. Automatic control of this heating process can be obtained with photocells by controlling the flow line which separates unfused tin (dull matte) and fused tin (bright) on the strip

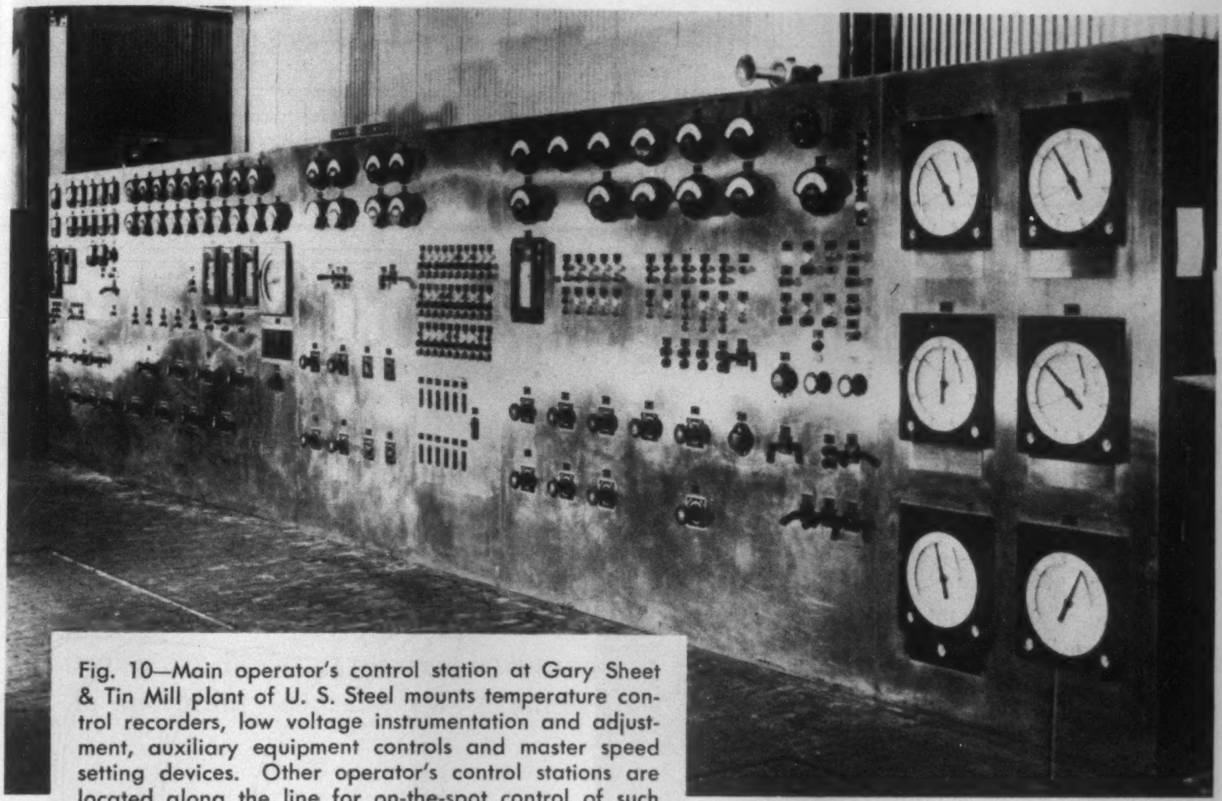


Fig. 10—Main operator's control station at Gary Sheet & Tin Mill plant of U. S. Steel mounts temperature control recorders, low voltage instrumentation and adjustment, auxiliary equipment controls and master speed setting devices. Other operator's control stations are located along the line for on-the-spot control of such operations as uncoiling and coiling

continuously change speed to compensate for the changing coil size and motors must be capable of changing speed to feed or take up a loop. Adjustable-speed direct-current motors used are designed for flat speed regulation to hold their speed even with change in load. Slowing down or speeding up of any section is accomplished by changing the field current of the drive generator. If the line contains three sections, three generators may be operated as a unit for normal operating speeds throughout the line. The generators may also be operated independently to control the speed of the line for any section.

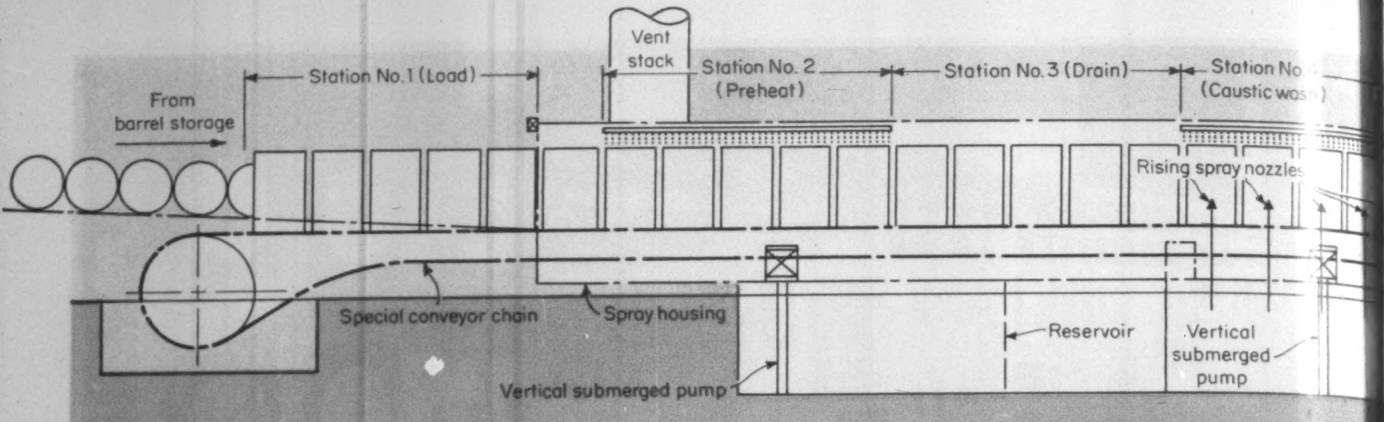
An additional advantage of continuous processing requires mentioning—the opportunity for automatic inspection. Perforations in a sheet can be detected by photoelectric means. If the perforation passes light to actuate a photocell the strip can be automatically marked or, if inspected as a cut sheet, it can be automatically rejected. Sheets or strip can also be automatically checked for size with flying micrometers. This device consists of two rollers which displace the magnetic armature of an alternating bridge circuit as a result of relative movement—thereby producing a voltage unbalance of the circuit which represents variation in thickness. The instrument is set for zero current flow for the proper thickness so that oversize or undersize sheet will actuate the reject device.

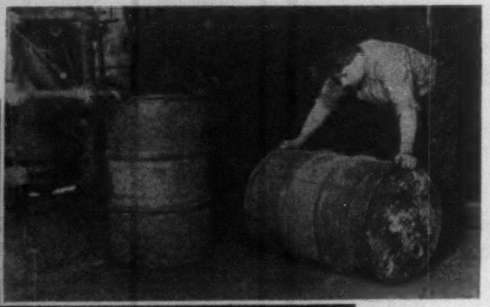
▸ General Comments

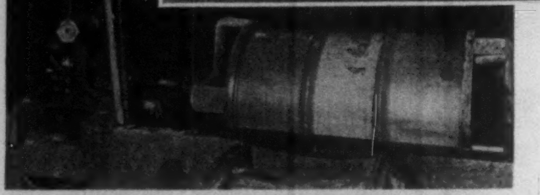
In addition to tin, continuous plating lines are used for zinc, copper, brass, nickel, chromium and lead-tin alloy. It may be of interest to note that continuous zinc plating, known as electrogalvanizing, has been practiced commercially since 1910.

Continuous processing lines are also used for hot dipping processes, such as galvanizing and hot tinning. Since these lines are relatively slow compared to electrolytic lines the need for automatic control has not been as great. Hot processes such as annealing, tempering and heat treating are limited in speed by the fact that time becomes a factor. In many such lines temperature control and atmosphere control become the primary problems. Control means are conventional with the exception that special handling problems may arise with continuous passage of strip through a hot medium.

There are several basic disadvantages to a continuous strip process. First there must be enough demand for the product to keep the line busy. There will be some minimum speed below which it will not be economical to operate the equipment. Secondly, the process is fixed. Extra steps cannot be easily added or dropped. Also the line may be limited as to the thickness and width of sheet that can be conveyed. While these considerations seldom present serious problems for high-production products, they may become limiting factors for small scale continuous processing.


Vent stack
From barrel storage
Station No. 1 (Load)
Station No. 2 (Preheat)
Station No. 3 (Drain)
Station No.
(Caustic was
Rising spray nozzles
Special conveyor chain
Spray housing
Reservoir
Vertical submerged pump
Vertical submerged pump





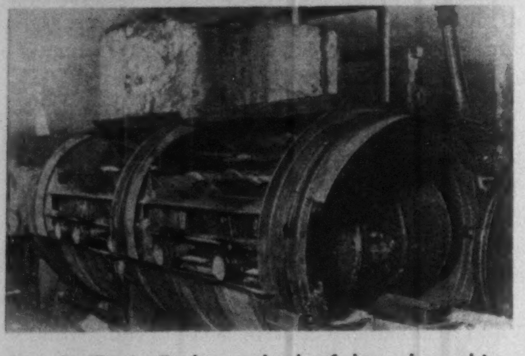


Fig. 1 (Top)—Early method of barrel washing required manual manipulation of 110-pound barrel as it was successively charged with steam, kerosene, caustic wash and rinse water. Exterior was hand washed

Fig. 2 (Center)—Power-driven washing machine rotated individual barrel in cleaning solution; a submerged wire brush scratched off paint and loose rust as charge of solution slushed interior

Fig. 3 (Bottom)—Early form of mechanical washer, shown in open position, handled five barrels at one time. Barrels were rolled into position and registered with funnel shaped guides through which spray nozzles would enter when fixture was rotated to wash position

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OBSOLETE production methods are invariably spotlighted by the bottleneck conditions resulting from the stress of increased production requirements. Fundamentally a function of demand, increased production needs, however, can be attributed directly to other factors in some instances. As an example, consider the replacement of unsatisfactory wooden casks used in the early days of petroleum product marketing with the more expensive steel barrels presently used. The feasibility of replacement was predicated upon the ability of the refinery to clean the returned barrel and this cleaning operation eventually became a production bottleneck. An early example of automation developed before the word was even coined, the solution to the problem proved to be automatic barrel cleaning—the results enabled the Standard Oil Co. (Indiana) to literally "roll out the barrels".

Returned barrels were frequently badly contaminated with foreign products, often due to improper use by customers, and would accumulate after a period of service many coats of paint which were unsightly and difficult to remove by ordinary means. Early barrel cleaning was done manually, *Fig.* 1. This consisted of preliminary steaming to warm up the barrel in cold weather, allowing heavy

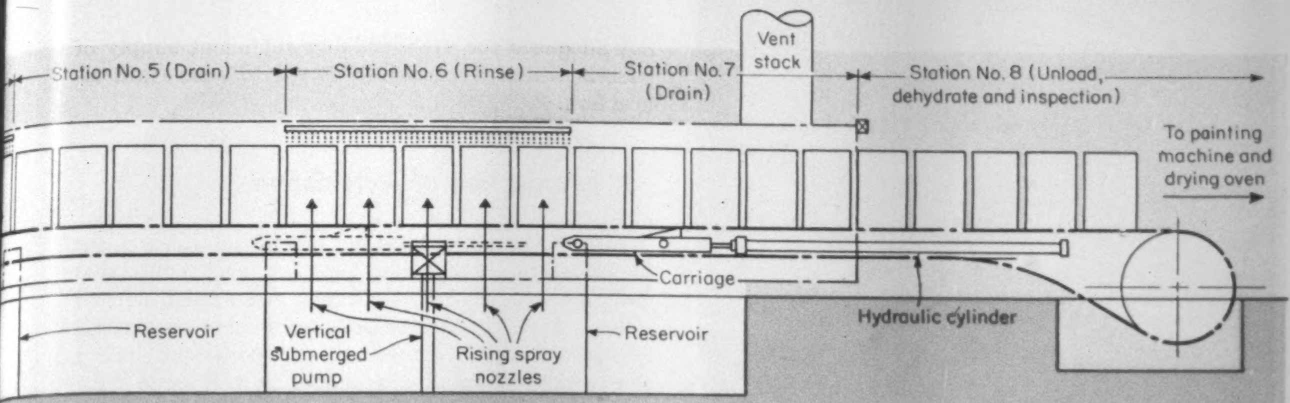


Fig. 4—Specially designed barrel washing machine takes form of continuous production line. Barrels are manually loaded and unloaded

Faced with the necessity of upgrading a container, many industries have justified the adoption of a more expensive type based upon the reuse potential. As a manual operation, preparing a quantity of used containers for reuse can be an expensive, irritating and unattractive job. But as an automatic operation—consider this example of barrel cleaning in a refinery

AUTOMATIC BARREL CLEANING SOLVES A DIRTY PROBLEM

oils and sometimes molasses and other foreign substances to drain out easier. This was followed by successive internal rinses with kerosene, caustic solution and hot water, during which time the barrel was rolled, rocked and otherwise manipulated to improve the cleaning effect. Each batch of internal cleaning solution was discarded. The outside of the barrel was swabbed with kerosene and wiped by hand. These operations required considerable back-bending and twisting, physical effort and dexterity to handle barrels weighing 110 pounds under room conditions of high temperature and humidity. This sapped an operator's strength and energy, especially in hot summer weather. In the winter time the room became so foggy that visibility was often restricted to less than ten feet, depending on weather conditions. This was literally a "sweat shop" occupation but seemingly necessary at that time.

▶ Early Forms of Mechanization

Conditions were somewhat improved by the use of power-driven rotating barrel cleaning machines which rotated barrels on a horizontal axis, partly submerged in an open box containing a hot caustic solution, *Fig.* 2. A stationary submerged wire brush contacted the outside of the barrel to scratch off what old paint could be removed in a given time while the inside was being rinsed with a charge of hot cleaning solution. This was an improvement over the older hand method of barrel cleaning but still involved splashing of hot caustic solution and considerable manual handling.

As production requirements kept growing and as industry was becoming more safety conscious, a need was felt for a better means of cleaning barrels. Such barrel cleaning equipment as was commercially available at the time was inadequate, so a new type of mechanical barrel washing machine was designed to reduce manual handling and increase cleaning effectiveness. The production capacity was considerably greater than any previous method used; the equipment was power operated but manually controlled.

The unit consisted of a large horizontal cylindrical shell with open ends and open front into which five horizontal barrels could be rolled directly on skid rails, *Fig.* 3. The barrels were manually located so that their end bungholes coincided with funnel shaped nozzle guides which projected for-

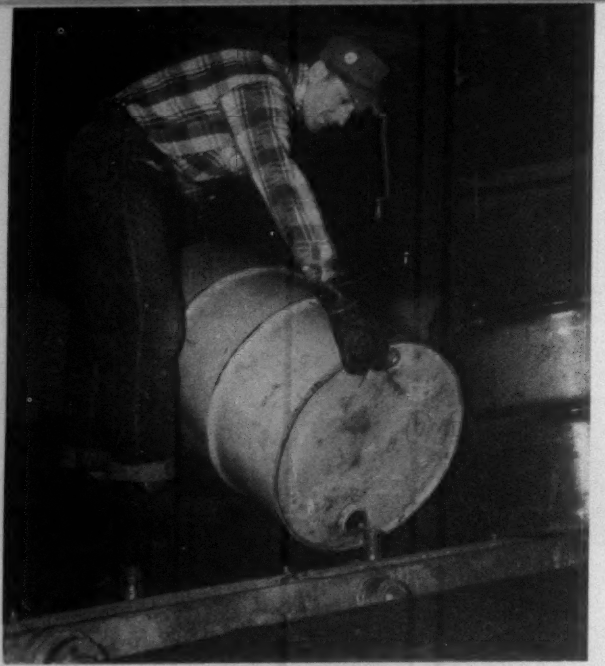


Fig. 5—Operator places barrel onto conveyor with bunghole over special nozzle guide which is integral with the conveyor chain

ward into the bungholes. The entire machine housing was then power rotated 100 degrees, stopping with the bungholes down. This operation automatically closed the front opening and the two end doors to prevent escape of any liquid from the spraying operation. With the spray housing closed another mechanism was manually engaged which automatically started a pump and simultaneously began to extend a spray nozzle into each barrel. After spraying this was followed by automatic retraction of the spray nozzles, automatic disengagement of the operating mechanism and shut-off of pump. Both interior and exterior of barrels were thus sprayed simultaneously with hot caustic solution following which the machine was power rotated back to the original position. The barrels were then rolled out of the first machine and into a second similar machine for a hot water rinse. Operations proceeded in a batch system of five barrels at a time, with improved safety and reduced manual effort.

However, unfavorable weather conditions and peak production demands often combined with other factors to create a bottleneck in the barrel cleaning department. Operations often extended through three shifts which tended to increase overhead and production costs and also imposed the inconvenience of shift work schedules. It appeared that many strong backs, hard labor and mechanical aids were not adequate for a dependably sufficient supply of barrels which were clean enough to pass rigid inspection.

▶ Introduction of Automation

Automatic barrel washing machines were not yet in use at that particular time but such equipment did give promise of increasing production, setting a dependable production pace, producing consistently clean barrels, concentrating operations into a comparatively small space and, at the same time, lessening the manual effort and producing more comfortable working conditions. With this early realization of the benefits of automation, a completely automatic barrel cleaning machine, containing many patented features, was designed. As developed and still used, this machine took on the general form of a production line consisting essentially of a long special conveyor chain to transport barrels in an upright position; a long, insulated, tunnel-like housing through which the barrels pass for spraying and draining operations; and an arrangement of stationary and movable spray nozzles operating mechanically to spray barrels externally and internally, *Fig.* 4. The barrels advance five at a time, intermittently and simultaneously through each of eight stations, requiring no manual handling in the course of the cleaning operations except loading and unloading.

At Station 1 an operator places the barrels on a conveyor with bungholes down over special nozzle guides, *Fig.* 5. Barrels waiting to be loaded and transported through the machine are shown in *Fig.* 6. Initial drainage of barrels takes place previously to barrels entering this area, but properly designed facilities would permit initial drainage at this station. At Station 2 barrels are sprayed externally for an initial cleaning and preheating of the barrel metal to hasten drainage of any oil or sludge remaining in the barrel; this is especially necessary

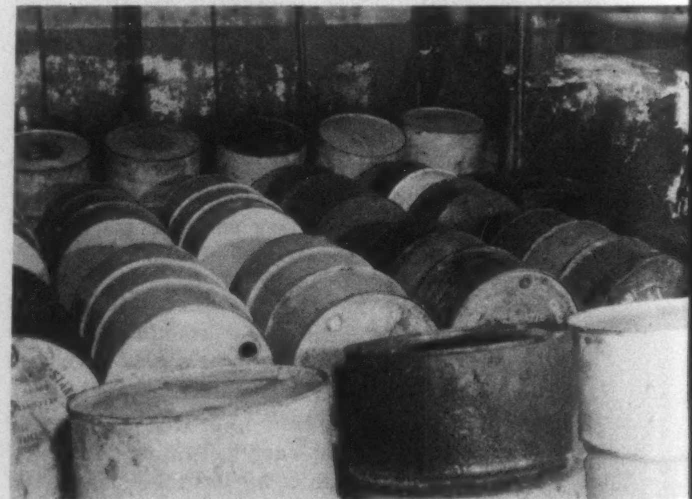


Fig. 6—Barrels waiting to be loaded at the front end of the machine. The horizontal barrels have been rolled into position on rails prior to loading on conveyor; vertical barrels have already been placed over the nozzle guides on the conveyor

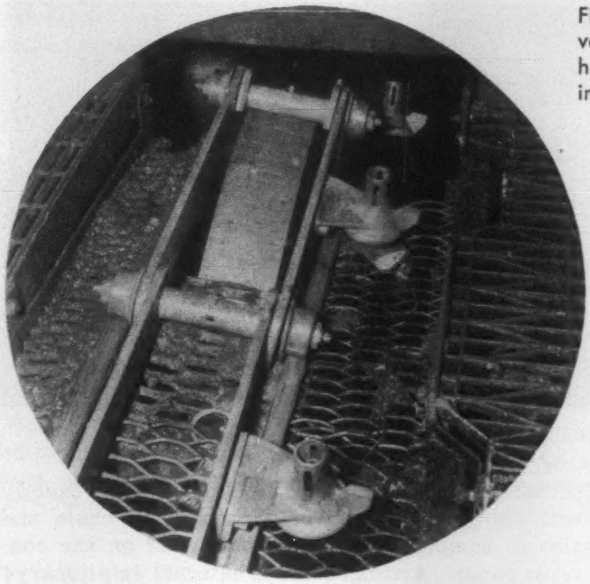


Fig. 7—Flanged rollers running on rails support special conveyor chain. Funnel shaped nozzle guides register bunghole in barrel with rising spray nozzles in washing and rinsing operation. The slots facilitate drainage

in cold weather. Barrels continue to drain at Station 3. At Station 4 barrels are pressure sprayed both internally and externally with a strong hot cleaning solution which also softens and removes paint. Barrels continue to drain at Station 5. At Station 6 barrels are pressure sprayed internally and externally with hot filtered water. Barrels drain at Station 7 before emerging from the machine. Barrels are unloaded on alternate sides at Station 8 and the empty conveyor proceeds to duck down and under on its return run.

▶ Design Details

The special conveyor chain consists of a continuous linkage of heavy bars with flanged rollers running on rails to support barrels on 26-inch centers. Barrels are placed over the funnel-shaped nozzle guides which are mounted on one side of the chain, *Fig.* 7. These guides register with rising spray nozzles at Stations 4 and 6. The chain is installed in a tilted position to locate barrel bungholes at their lowest point, and nozzle guides are slotted to facilitate drainage.

A hydraulic cylinder having a piston travel of 11 feet 9 inches is mounted directly under the carrying run of the conveyor chain, near the end of the run, *Fig.* 8. The linear movement of the piston is utilized to propel the conveyor chain five barrel spaces at each movement. Acceleration and deceleration of piston speed is controlled by mechanical linkage. Various other linkages and mechanisms utilize this basic linear movement and power in controlling the operation of the machine because of the inherent relationship between piston movement and operating functions.

A special carriage attached to the hydraulic piston propels the conveyor chain forward by means of a driving dog which is automatically and positively raised by the initial movement of the piston, *Fig.* 9. A special cam design is provided to positively raise a chain stop near the end of the pis-

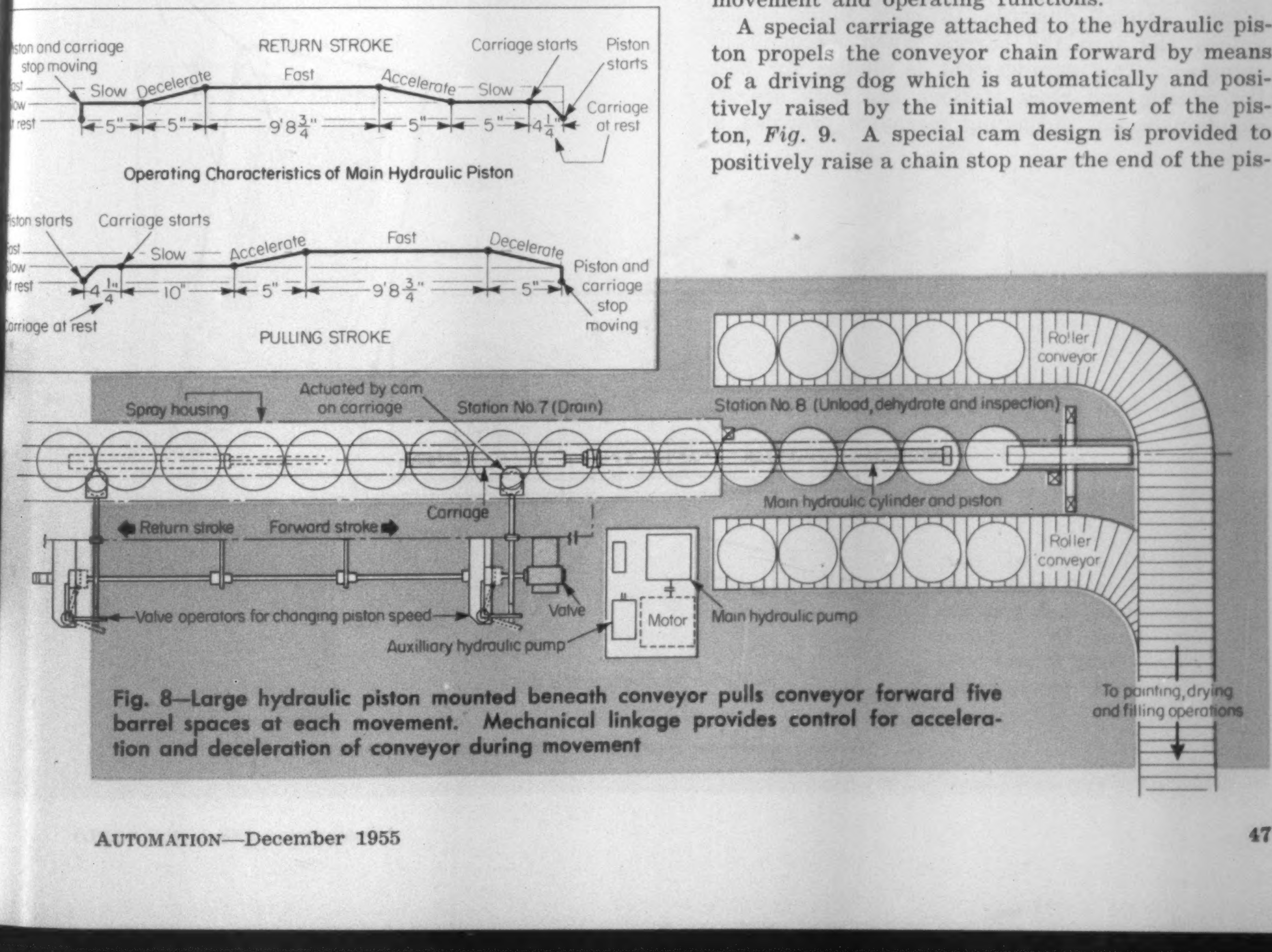

ston and carriage stop moving
ast
ow
t rest
RETURN STROKE
Slow
Decelerate
Fast
Accelerate
Slow
Carriage starts
Piston starts
Carriage at rest
5"
5"
9'8¾"
5"
5"
4¼"
Operating Characteristics of Main Hydraulic Piston
ston starts
Carriage starts
ast
ow
t rest
Slow
Accelerate
Fast
Decelerate
Piston and carriage stop moving
4¼"
10"
5"
9'8¾"
5"
arriage at rest
PULLING STROKE
Spray housing
Actuated by cam on carriage
Station No. 7 (Drain)
Station No. 8 (Unload, dehydrate and inspection)
Roller conveyor
Main hydraulic cylinder and piston
Roller conveyor
Carriage
Return stroke
Forward stroke
Valve operators for changing piston speed
Valve
Motor
Main hydraulic pump
Auxilliary hydraulic pump
To painting, drying and filling operations

Fig. 8—Large hydraulic piston mounted beneath conveyor pulls conveyor forward five barrel spaces at each movement. Mechanical linkage provides control for acceleration and deceleration of conveyor during movement

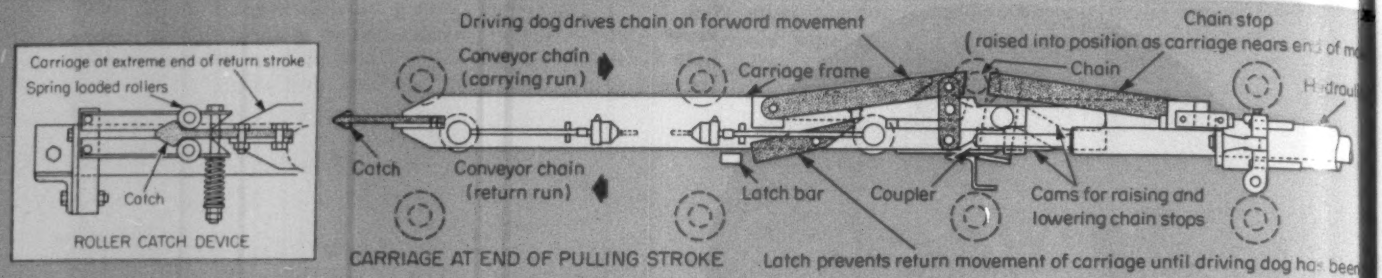

Carriage at extreme end of return stroke
Spring loaded rollers
Catch
ROLLER CATCH DEVICE
Driving dog drives chain on forward movement
Conveyor chain (carrying run)
Catch
Conveyor chain (return run)
Carriage frame
Latch bar
Coupler
Chain stop
(raised into position as carriage nears end of m
Chain
Hydraul
Cams for raising and lowering chain stops
CARRIAGE AT END OF PULLING STROKE
Latch prevents return movement of carriage until driving dog has been

Fig. 9—Carriage attached to hydraulic piston moves conveyor chain forward. Special stop, actuated as carriage reaches foremost position, provides positive location of barrels with relation to automatic spray nozzle mechanism

ton stroke which positively stops the conveyor chain at a precisely adjusted point of registration to coincide with the location of spray nozzles which rise upward into the barrels through special nozzle guides. Initial reverse movement of the piston first lowers the driving dog and then positively lowers the chain stop as the carriage begins its return movement. A special spring-loaded holding device engages the carriage at the end of its return stroke. This provides an adjustable resistance to initial forward movement which insures that the driving dog will positively rise before carriage movement begins.

Internal spray nozzles of a special design are attached to the upper ends of curved pipes which in turn are mounted on movable headers attached to swing pipes. These are actuated by a crankshaft powered by a double-acting hydraulic cylinder with a gear rack and linkage, *Fig.* 10. The spray nozzles extend upwards through funnel-shaped guides and into the barrels when mechanically actuated. This arrangement is similar for both the caustic and rinse stations and both operate simultaneously. Adjusting means is provided to permit centering the nozzles to coincide exactly with the nozzle guides on the conveyor chain and also to compensate for eventual wear on the conveyor chain. Arrangement of external (stationary) sprays is similar for all three spraying stations, including preheat, caustic and rinse operations at Stations 2, 4 and 6.

Pumps which supply the pressure circulation at three spraying stations are vertical turbine type pumps whose intake is submerged directly in the liquid being pumped, *Fig.* 11. This arrangement eliminates pump pits and suction piping to minimize suction losses, provides for a simple installation, saves space, improves accessibility and favors operating conditions for electric motors. Pumps for the preheating spray station (station 2) operate continuously, but pumps for the succeeding internal spray stations (stations 4 and 6) operate

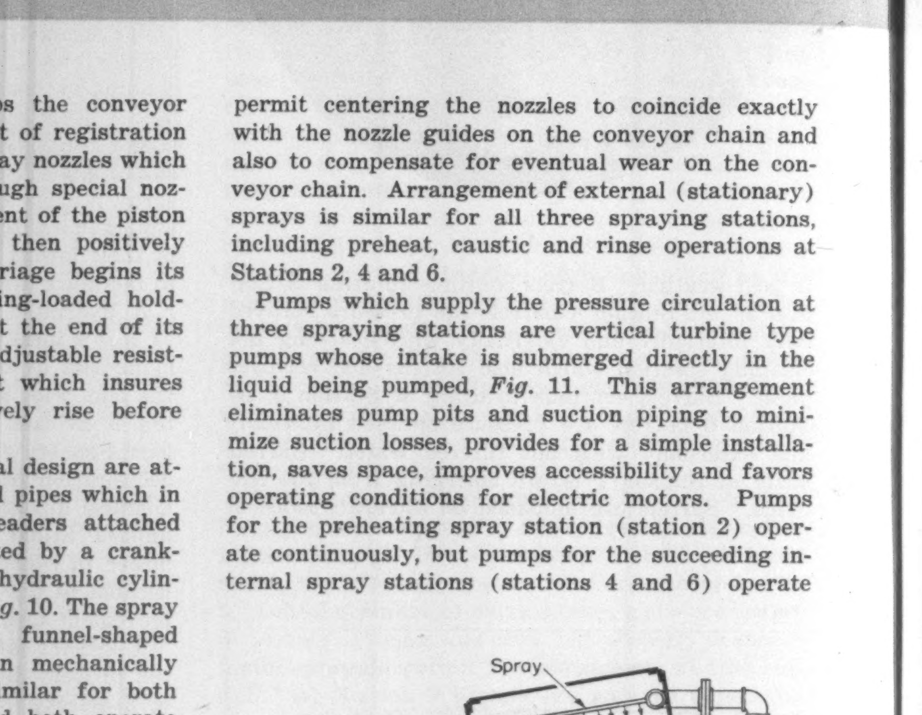

Spray
Spray
Spray housing
Nozzle guide
Spray
Conveyor chain drive
Aux. piston
Reservoir
Rising nozzle pipe
Pump pressure
Symmetrical about this ℄

Fig. 10 — Internal spray nozzles are raised into position by rack and pinion driven by hydraulic piston. Note various types of barrels which system will handle

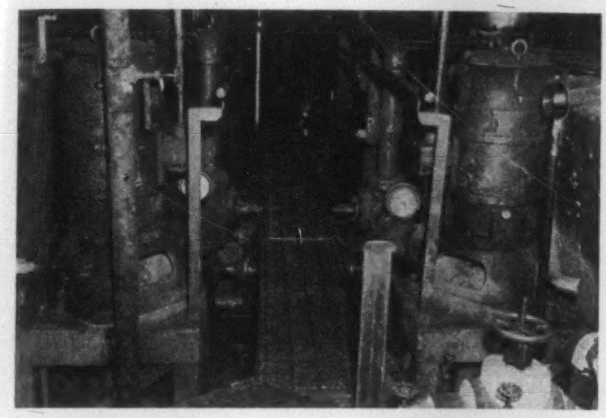


Fig. 11—Vertical turbine type pumps supply circulation at the three spraying stations. Preheating station operates continuously; other spraying stations operate intermittently

only while the nozzle raising mechanism is in motion. The spraying effect is carefully designed for good distribution of liquid over all barrel surfaces and to give maximum impingement of streams which improves the starting effect of breaking through the surface of paint and scum accumulations.

At the rinsing station (Station 6) hot water is recirculated and filtered. For supercritical cleaning requirements an alternate arrangement can be used which involves a separate supply of fresh filtered hot water for internal rinsing only. This water is used once only then serves to freshen the water supply for external rinsing which recirculates.

▶ Hydraulic System Is Reliable

Hydraulic power is used as the principal actuating medium for many reasons, including its great flexibility of application in permitting complicated and extreme movements by simple means, steady and dependable action with a broad range of adjustable speed variations, and quiet action with a minimum of wear and maintenance. The fact that a hydraulic system must be kept tight to retain oil, also serves to keep dirt and foreign matter out of the system and its hydraulic mechanism. A single electric motor serves to operate hydraulic equipment which in turn efficiently serves all mechanical operating and control functions for an entire unit.

A hydraulic control system is preferred to an electrical control system under given conditions primarily because of its greater flexibility, range of operating adjustments, smoother and more direct action and dependability, but also because of lower cost, simplicity, less maintenance and reduced fire hazard. Mechanical control linkages are preferred to hydraulic or electrical controls at the initial action points because they are positive, rugged, and not affected by adverse operating conditions involving heat, splashing, vapors, corrosion and inaccessibility. Furthermore, the mechanical controls can be readily adjusted or serviced externally while equipment is in operation, otherwise production would be interrupted and delayed while waiting for equipment to cool sufficiently to allow access to interior locations.

The hydraulic flow diagram, *Fig.* 12, explains the operation, functions and interlocking features of the control equipment. A graphical representation helps to visualize the sequence of control func-

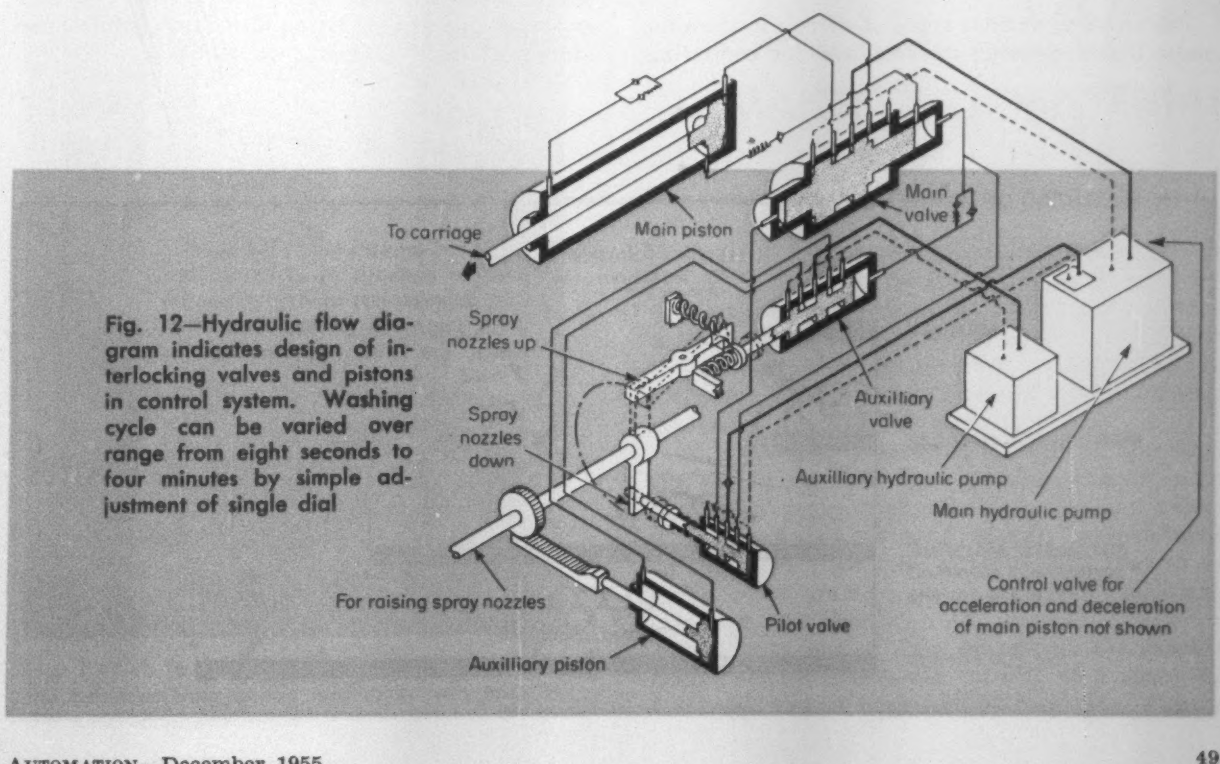


Fig. 12—Hydraulic flow diagram indicates design of interlocking valves and pistons in control system. Washing cycle can be varied over range from eight seconds to four minutes by simple adjustment of single dial

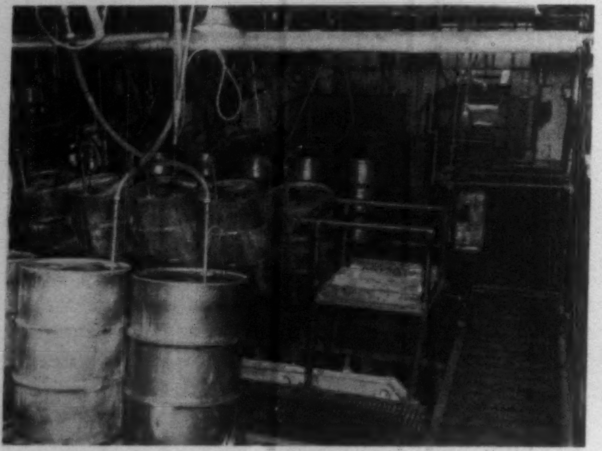


Fig. 13—Suction nozzles remove final traces of moisture from the cleaned barrels at the last station

tions and the operating characteristics of the main hydraulic piston through a complete cycle of operation.

At the completion of the cleaning operation the barrels are upended on tilted roller conveyors to facilitate inspection and removal of moisture which collects at the lowest point. Moisture removal is accomplished by means of suction nozzles inserted in the bungholes, *Fig.* 13. Removal of some remaining moist air in the barrels could be improved somewhat for critical requirements by introduction of hot dry air through a tube, but passage of the barrels through a hot drying oven, subsequent to painting, usually suffices.

▸ Control Is Simple

For cleaning various types of barrels in the automatic barrel cleaning machine and for controlling the degree of cleaning desired, the principal operating adjustment consists of a single control dial for varying actual washing or spraying time through a range from eight seconds to four minutes. For conditions involving wide variations of cleaning time it has been found economical to segregate barrels into two or more general categories by preselection and to process all the barrels of one category at the same time. The spray timing adjustment is also useful for extending the cleaning time when inspection shows that barrels are not being cleaned sufficiently due to the cleaning solution becoming spent or weakened prior to a scheduled shutdown of operations when the solution would normally be replaced.

The maximum processing capacity of one machine (single line) is 15 barrels per minute or 900 barrels per hour, but actual production depends on the condition of barrels, strength or freshness of the cleaning solution, temperature of incoming barrels and of solution used, and the degree of cleaning desired. Actual average production of 150 to 200 barrels per hour is a conservative figure based on average conditions which include various extraneous factors and delays involved in a full week of operation, *Fig.* 14. The potential production rate is considerably higher for barrels requiring only a minimum of cleaning.

In its hundred feet of length there is no suggestion of glamour about this machine. In fact, all operations occur out of sight inside the long enclosure, but it is fascinating to see dirty barrels enter at one end and come out clean at the other end. Automatic barrel cleaning not only produces more and cleaner barrels cheaper and faster but it eliminates the backache and human toil and sweat which was formerly inherently associated with manual barrel washing. Automatic machinery today does all the hard, hazardous, dirty work and sets a production pace which justifies today's higher wages and higher living standards, while operators work more safely and comfortably.

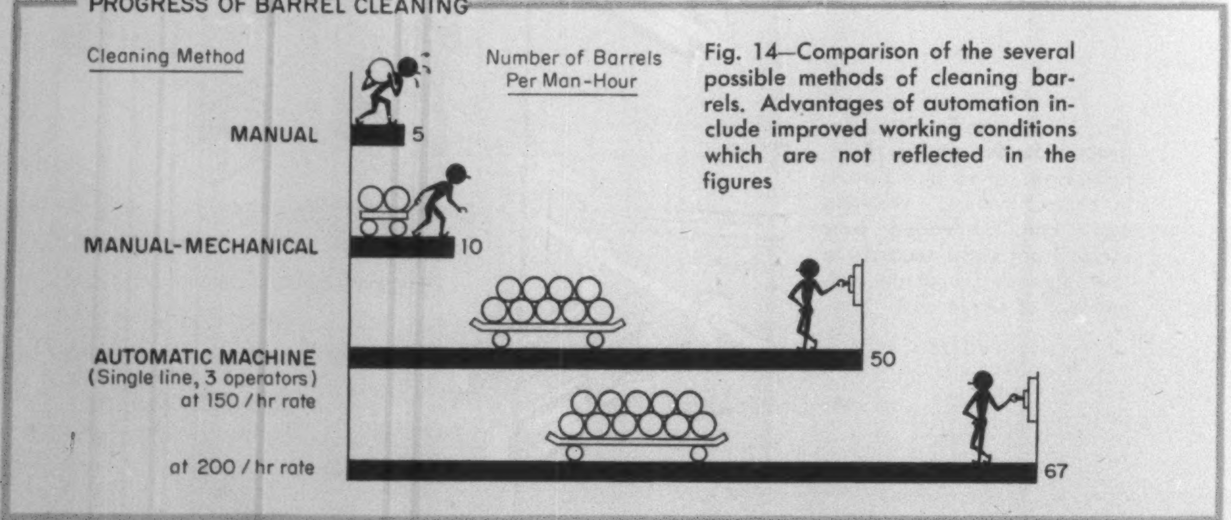


Fig. 14—Comparison of the several possible methods of cleaning barrels. Advantages of automation include improved working conditions which are not reflected in the figures

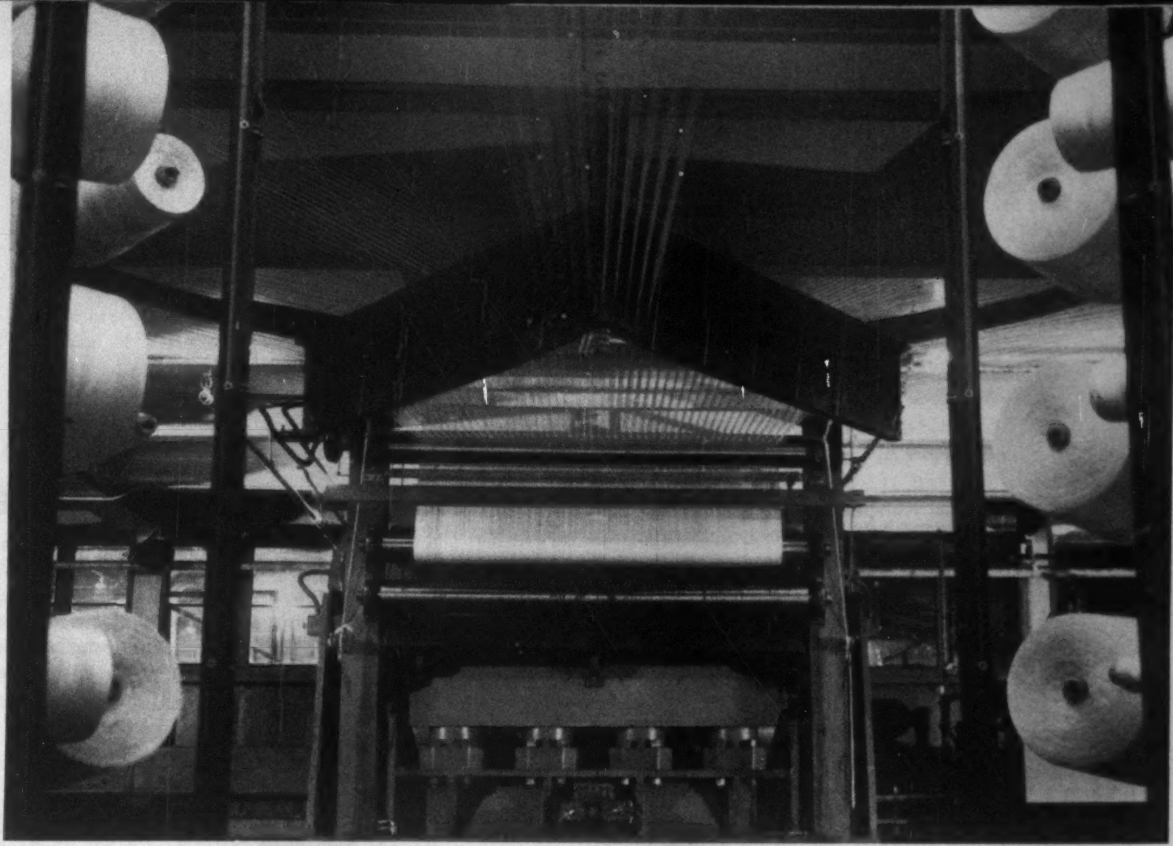
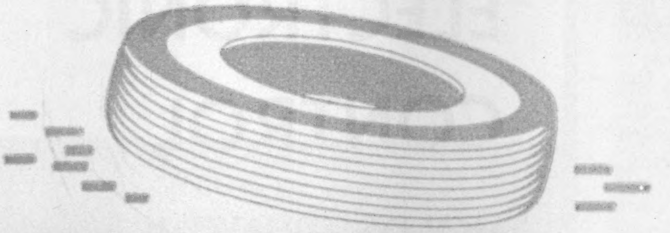


Fig. 1—Some 2500 strands of nylon tire cord are gathered together in this eyelet board to form a complete web approximately 66 inches wide



CALENDER TRAIN

MAKES TIRE MATERIAL

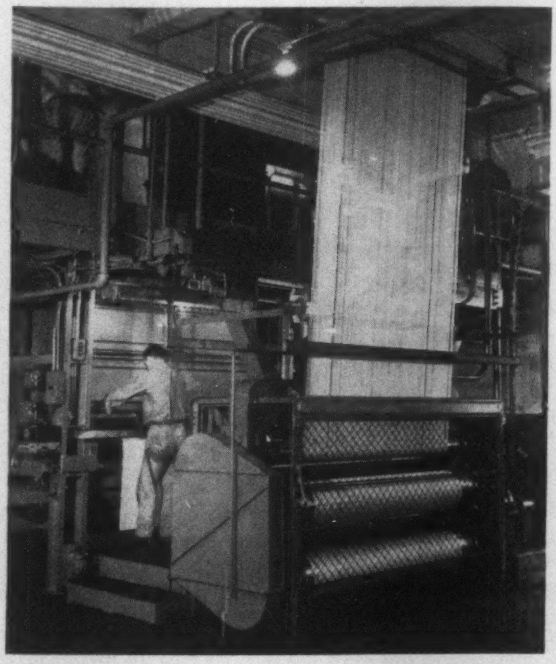


Fig. 2—Web of nylon tire cords is shown entering the calender train at the tensioning rolls prior to dip tank immersion

SET-STRETCHED nylon tire cord is used by B. F. Goodrich in the manufacture of truck, bus, off-the-road, airplane, and passenger car tires, including an all nylon cord tubeless tire. To boost tire production by 20 per cent at their Oaks, Pa. plant the company has designed and installed a mammoth new calender train.

This unit was designed to incorporate the Goodrich nylon weftless creel process wherein nylon tire cords are coated with adhesive and rubber while prescribed uniform tension is maintained on each cord. This type of material is used to obtain a cooler running tire that provides maximum safety at high speeds.

Built at a cost of some $2 million, the calender train occupies nearly the entirety of a space 380 feet long, 34 feet high, and 60 feet wide. This installation represents the latest continuous processing improvements on a basic process that has been used by this company for more than seven years.

At the start of the run, *Fig.* 1, 2500 strands of nylon cord are passed through an adhesive dip and an air dryer section where the cord is treated at high temperatures under controlled tension. It is next passed through a four-roll calender section, *Fig.* 2, where both sides are laminated with rubber while still in a weftless form, *Fig.* 3. The material completes its run by being treated with adhesive cement and wound on rolls for the fabrication preparation section.

Heart of the calender train is a 30-foot long master control panel from which an operator oversees the entire continuous process. In case of trouble, automatic devices shut down the entire calender train while one or more of a bank of 40 annunciator lights on the control panel indicate the source of trouble. There are 60 control and indicating devices and 40 measuring and recording units on the control panel which record progress of the entire operation.

Communications between the master control operator and the calender crew are maintained through a private telephone exchange with 32 outlets. The system also has a public address setup. One safety device continuously samples the air for hazardous mixtures in the cement dip enclosure while another mechanical watchdog operates a carbon dioxide fire extinguishing system.

This installation, which is believed to be the only one of its type in the world, serves as another example of the application of the principles of automation to achieve continuous processing.

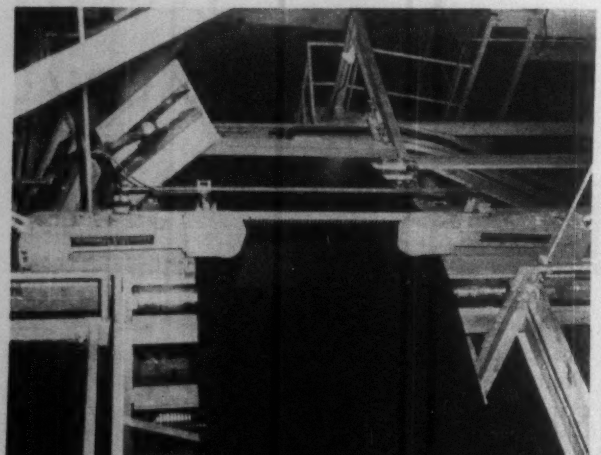


Fig. 3—Rubber-coated nylon tire fabric is shown here passing through Industrial Nucleonics gages which measure thickness of the fabric and uniformity of the coating in one of the concluding steps in the continuous processing of nylon tire cord at the Oaks, Pa. plant of the B. F. Goodrich Co.

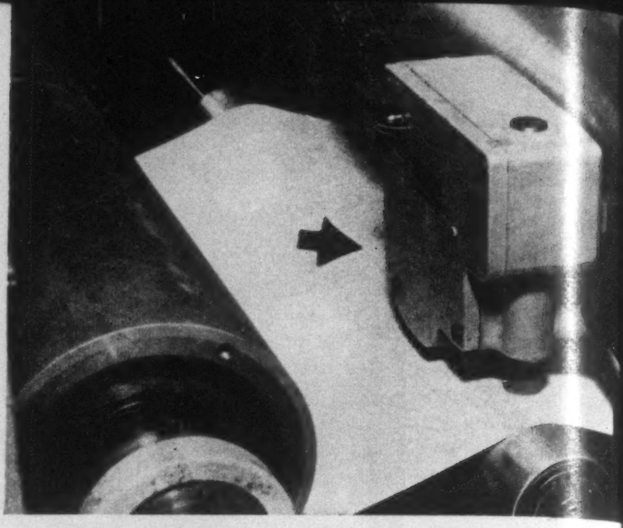


Fig. 1—Primary sensing unit in this registration control system is a photoelectric scanner indicated by an arrow. An impulse indicating web positioning can be triggered by a characteristic point in the pattern being printed without requiring a special registration mark or track on the web

ANTICIPATING ELECTRONIC CONTROL

HOLDS PRINTING IN REGISTER

AN ESSENTIAL REQUIREMENT in printing with modern high-speed rotary presses is fast, accurate registration of the web or stock being printed as it moves through each successive unit. Accurate registration is essential not only for printing, but also for such other in-line operations as rotary cutting and roll-fed die cutting. To meet this requirement, Champlain Co. Inc., manufacturer of rotary presses and printing equipment, has developed an electronic register control system employing a photoelectric eye.

A complete control system, it consists of a web scanner, photoelectric phase detector and control unit. The system continuously inspects the moving web and the rotating printing cylinder. It anticipates off-register before the web reaches the cylinder, and advances or retards the printing cylinder as required.

An explosionproof web scanner, *Fig.* 1, is mounted between operating units in a position where it can view the web at any point across its width. In printing lines, it scans the stock in advance of the printing cylinder so errors can be anticipated. Target of the web scanner is a register mark or solid color area. As the target moves through the optical field of the scanner it sets off an electrical impulse. This is amplified and relayed to the control panel.

The phase detector, shown in *Fig.* 2, is mounted near the rotary cylinder shaft and is coupled to it so they rotate synchronously. Function of the detector is to determine the precise angular position of the printing cylinder relative to the web and to relay this information to the control unit. Two square waves with a dead space between them are generated by the phase detector. One of these waves is called the lead gate, or wave ahead of the register mark, and the other the lag gate, or wave that follows it. When the web is being printed in perfect register, the impulse set off by the target or web mark falls exactly in the dead zone, which is usually adjusted to represent a length of 0.005-inch, depending on press requirements. Any variation from dead center exceeding 0.0025-inch will produce a signal for appropriate correction. Once set, this tolerance will remain uniform at speeds ranging from a low idling speed of 50 feet per minute to speeds as high as 1500 feet per minute. Any variation in the timing of the target impulse will instantly be sensed by the control unit and a correction initiated.

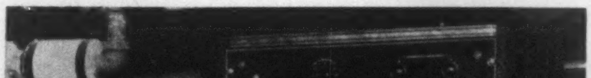


Fig. 2—Second necessary sensing unit is the phase detector shown by arrow. Output from this phase detector is a square wave signal having a dead zone into which the scanner impulse should fall for proper registration. Registry within 0.0025-inch may be obtained

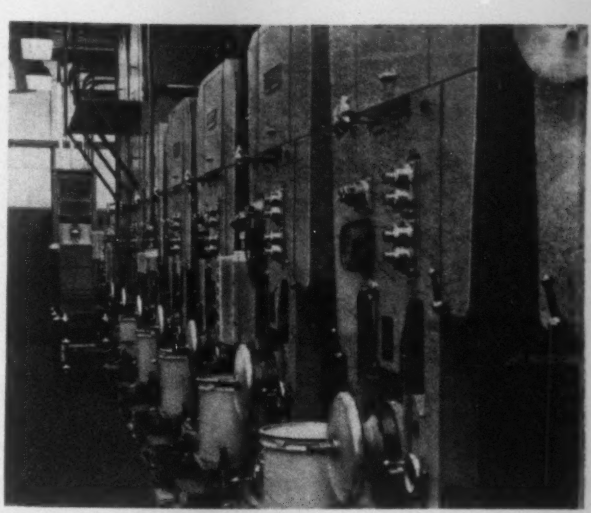


Fig. 3—In-line installations composed of several units may be synchronized for accurate registry in all operations. Such a printing installation is shown here with a master control unit at left rear from which registration of each machine in the line is controlled

Housed in the control unit, also visible in *Fig.* 2, are the tubes and circuits which compare web and cylinder registration and control the correction motor. Depending on the requirements of the installation, the correction motor may be a single-speed design for only fine phasing, or it may be a two-speed design for coarse and fine phasing.

Alternate circuits provide either pulsing or continuous correction. When a continuous correction is called for, the register correcting motor operates until the correction has been made. When pulsing correction is used a separate control governs the length of time that the correction motor will run.

Co-ordination of registration for a battery of presses can be built into a master control panel similar to that shown in the left background of *Fig.* 3. In such an installation both coarse and fine phasing can be controlled for all units from the central panel.

Highlights of the control system explained here include other points worth mentioning. No clear web track or printed register mark is required, edge and side trim is thus saved that would otherwise be wasted. Automatic leveling in the web scanning circuit eliminates the need for manually operated sensitivity control, greatly reducing the possibility of human error, and the system is independent of color variation. The phase detector is not sensitive to wear and does not depend on web speed. Loss of misregistered stock in starting a run is reduced by ability to adjust register while the presses are at a standstill. Panel components plug in so they can be easily replaced if necessary.

MARKET
COMPETITION
PRODUCTS
PROFIT

SET SPECS

DESIGN

ANALYZE

TEST •

BUSINESS SYSTEMS CAN BE ENGINEERED

By ROGER L. SISSON
Canning, Sisson and Associates
Los Angeles, Calif.

Since the exchange of goods first became known as business, this activity has been guided by an art described in terms ranging from "business intuition" to "the seat of one's pants." Industrial complexity has made this approach more and more unsatisfactory; the pace of automation has made it obsolete. A business science is growing—and adopting automation as its own

MANY BUSINESSMEN have not yet come to look upon the design of their information handling or data processing systems as an engineering problem, but such an approach may prove fruitful. The engineering approach has benefited business in the construction of buildings, power plants, refineries and other complex systems. This article describes a somewhat idealized approach to the engineering of business systems for those interested in improving present techniques.

Generally, an engineering job follows these steps:

1. Set specifications for the equipment or system.
2. Choose components and arrange them so as to accomplish the job in the most economical and reliable fashion. This step, as in any design step, requires a good knowledge of theory, experience and engineering know-how in relating available components to a workable system.
3. Test the proposed design by mathematical analysis.
4. Test by further analysis or by construction of a prototype or pilot model.
5. Construct, install, test and put into operation.

This engineering approach as applied to business system design is shown in *Fig.* 1.

One important point should not be overlooked—the theoretical background for business systems is somewhat weak—which explains why an engineering approach to business systems has been slow in arriving. Physics and chemistry, supported by mathematics, are available to the designer of physical equipment. Other sciences, economics and sociology (only recently being approached mathematically) are not as well developed. Perhaps the most important feature of operations research

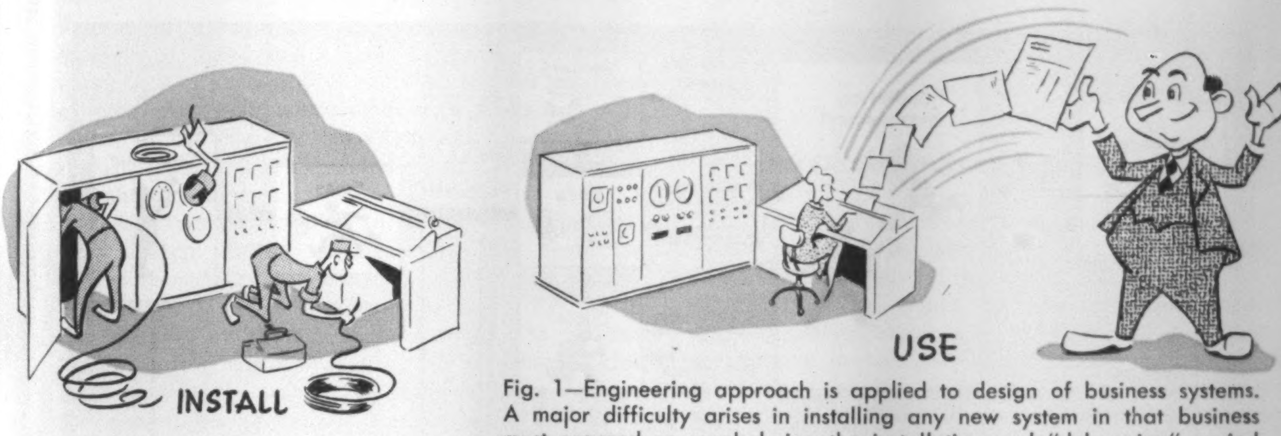


Fig. 1—Engineering approach is applied to design of business systems. A major difficulty arises in installing any new system in that business must proceed as usual during the installation and "debugging" period

is that it encourages the development of workable theories of the operation of business systems.

Specifications for Business Systems

Later we shall consider a possible theoretical basis for the design of business systems. First, let us apply the steps of the engineering procedure to the design of a business system.

In order to determine how to set specifications for a data processing system, what is generally required of such a system must be established. Data is processed in a business for four reasons:

1. Provide reports required by accounting and legal authorities (payroll tax reports, general ledgers, etc.)
2. Provide information in the form of reports which management needs to make intelligent decisions about running the business (cost reports, performance vs. budget reports, production reports, etc.)
3. Carry out the manipulations of data required where complex decision-aiding procedures are used (statistical market analysis, mathematical programming, etc.)
4. Transmit the information in the form of orders to operating people so that the desired activities will take place (purchase orders, shop orders, bank drafts, invoices, etc.).

Management of a particular business, then, must define exactly what it requires in each of these four categories. Of course, they must try to define their requirements not only for the present, but for the future, in order that the data processing system will not become obsolete too quickly as the company grows.

A careful study by business systems engineers of management policy and existing procedures (and perhaps a review of new management decision-making techniques) is usually required in order to obtain the details of specifications for the data processing system. These are then reviewed by management, and after necessary revisions, a set of working specifications is obtained.

Of course the establishment of specifications cannot go on without some reference to the equipment available for data processing. It is not uncommon for management to ask for more data than can economically be obtained (in relation to its value) by existing techniques. The engineers' knowledge of available techniques helps to guide the establishment of reasonable requirements.

Another aid in deciding which desirable reports can be produced economically by the data processing system is for management to assign a priority to their requirements. Obviously, legally required reports have topmost priority. The issuance of certain basic orders — payroll checks, purchase orders, shop orders, etc.—are also of high priority. Assignment of varying priorities to management reports is important. Requirements for intermittent special reports as well as routine reports should be analyzed to see how they will effect the data processing work loads. Care must be taken to see that management appreciates the cost of processing data so that only the information they really are going to use will be processed.

In setting the detailed specifications for the data processing system, the systems designer must determine a number of facts such as:

1. Exact content of each transaction and report in terms of the number of digits and characters required to carry the information.
2. Volume of data to be processed in terms of the number of transactions occurring and reports required.
3. Computation and rearrangement processes required in order to obtain the necessary reports from the data available.
4. Computations required by mathematical decision-aiding processes which management chooses to use.

The first two, and to some extent the third, of these points can be obtained only by careful surveys of a firm's operations—counts of the number of sales orders, purchase orders, shop orders, employees, and so on are required. Then each of these factors must be analyzed to determine the num-

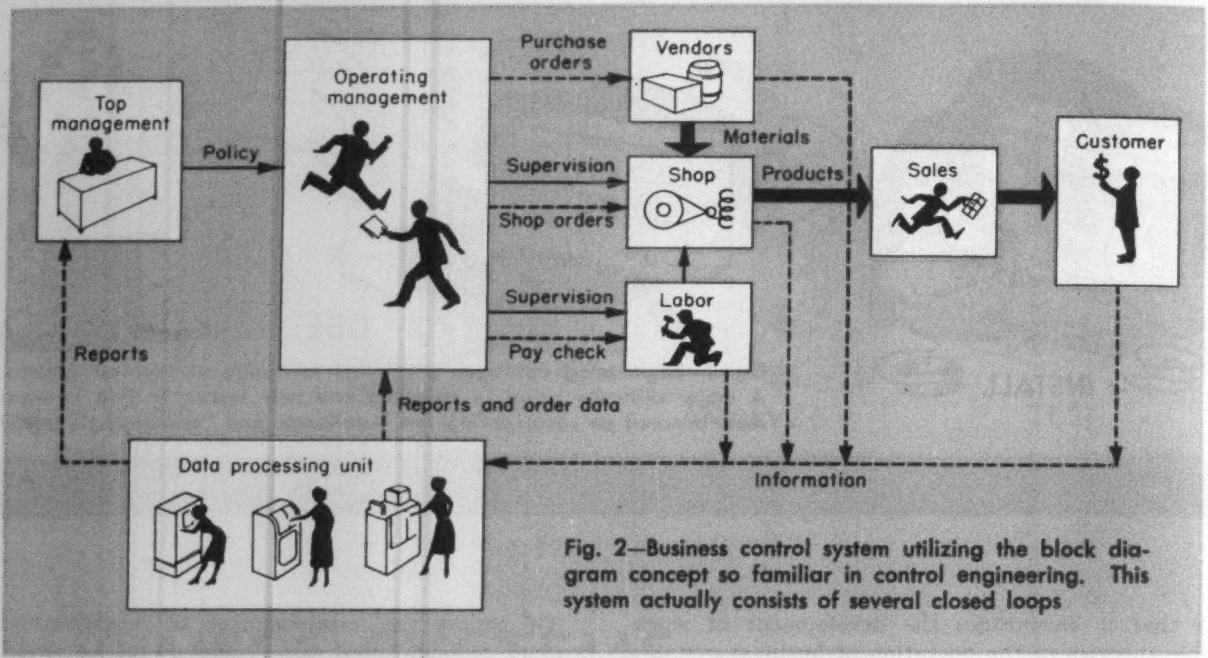
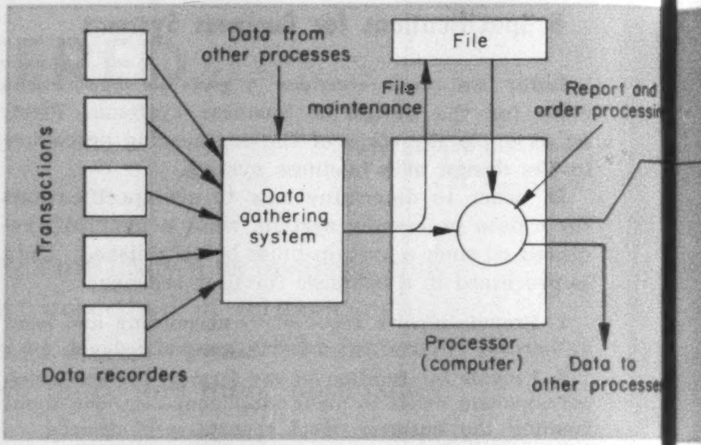

Top management
Policy
Operating management
Purchase orders
Vendors
Materials
Supervision
Shop
Products
Sales
Customer
Shop orders
Supervision
Labor
Pay check
Reports
Reports and order data
Data processing unit
Information

Fig. 2—Business control system utilizing the block diagram concept so familiar in control engineering. This system actually consists of several closed loops


Data from other processes
File
File maintenance
Report and order processi
Transactions
Data gathering system
Processor (computer)
Data to other processe
Data recorders

ber of digits needed to represent the important information and to develop methods of coding descriptive data. Likewise the format of reports must be established, so that printout requirements can be estimated. The computation and data handling required for decision-aiding processes are derived from operations research studies which might be carried out in conjunction with the data processing design.

In order to determine computational requirements, the systems designer must actually follow the processing through its various stages—whether elementary sorting, rearranging, summarizing and posting or complex mathematical procedures— in order to determine the requirements.

These steps apply whether the final system is manual, punched-card or electronic. However, the importance of accuracy in the volume measurements (number of digits, number of records, etc.) is higher in card and electronic systems.

▶ Design of Business Systems

Having developed a set of requirements or specifications (at least as far as end products are concerned) approved by management, the systems engineer enters the design stage. Here, as usual, no specific rules apply. The designer must combine his knowledge of business system theory and the techniques and components available with the particular specifications to develop a good economic system. Probably several systems will be proposed before a satisfactory one is chosen. As with any other engineering job, cost and reliability are key factors.

Most engineering disciplines have developed some techniques and rules for design which aid the designer in finding a good design quickly. The art of engineering business systems is somewhat newer than other fields, but some rules are being developed.

In the present state of the art, testing of a design by mathematical analysis is not possible in business systems. There is not enough mathematical theory on which to base an analysis, although there is some work in process which may lead to such theories. As a result, business systems must be evaluated by judgment. Fortunately, in many cases the procedures are mathematically quite simple, and it is not difficult to show that a particular procedure will produce the desired result by actually going through the procedure for test cases.

The problem of economic justification is also difficult. There has not been enough measurement and experience with data processing components (even manual systems) to be able to predict the volume of data which one unit can handle, nor enough to make quick cost estimates. However, enough data are available so that a good business systems engineer should be able to make fair estimates of the costs of installing and operating the system, with the expenditure of several man-months of study.

It is almost impossible to test a complete business system before installing it. The costs involved in setting up a test run or pilot run usually are not justified. It is possible to test a system in one division or section of a company (to get the "bugs" out) before installing it in others. Also it is possible to test some parts of the system—for example a particular routine on a bookkeeping machine, or an electronic computer program—before actual installation.

The problem of installing a business system is complicated by the fact that it must be introduced into an operating business with as little loss of information, time and profits as possible. This is more or less similar to trying to change the fire-control system of a fighter plane engaged in a dog fight. Careful planning can make this job easier.

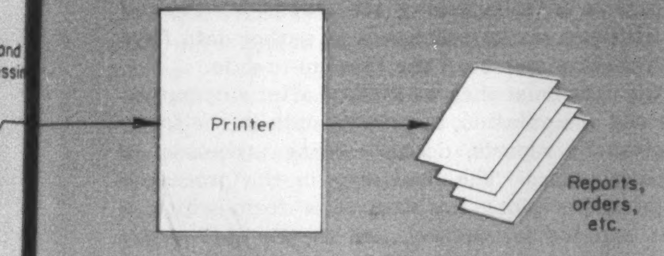


Fig. 3—Business data processing pattern in schematic form showing the handling of input (transactions) through internal processing to produce output (reports)

▶ Theoretical Feedback Analogy

Business system theory is in a state of growth at the present time and there appears to be no tested set of theories to guide the systems designer. There are many rules of thumb, and most of these are expressed in the accounting procedures which have grown over many years. It is recognized that these are inadequate in modern dynamic business, as they put too much accent on historical and legal problems. An analogous model that may serve to guide the thinking of those dealing with business systems is that of a closed-loop control system.

This is not a new idea—many engineers have indicated the similarity of a business to a closed-loop control system. (See "Basic Process Control," AUTOMATION, Oct. 1955). The Management Sciences Research Project at UCLA is beginning to develop this approach.

A closed-loop control system is one in which the output is compared with an input which is representative of the desired output. The error or difference is then used by the controller to decide what action to take in order to correct the error. In complicated systems not only the error, but rates of change and integral (historical) functions are also utilized by the controller. The business closed-loop system illustrated in *Fig.* 2 is actually a number of interrelated loops.

The analogy to control systems can help in establishing requirements and in designing the system. For example, the controlling element of each loop is a line executive. He must be provided

Courtesy Sperry-Rand, Inc.

Courtesy IBM Corp.

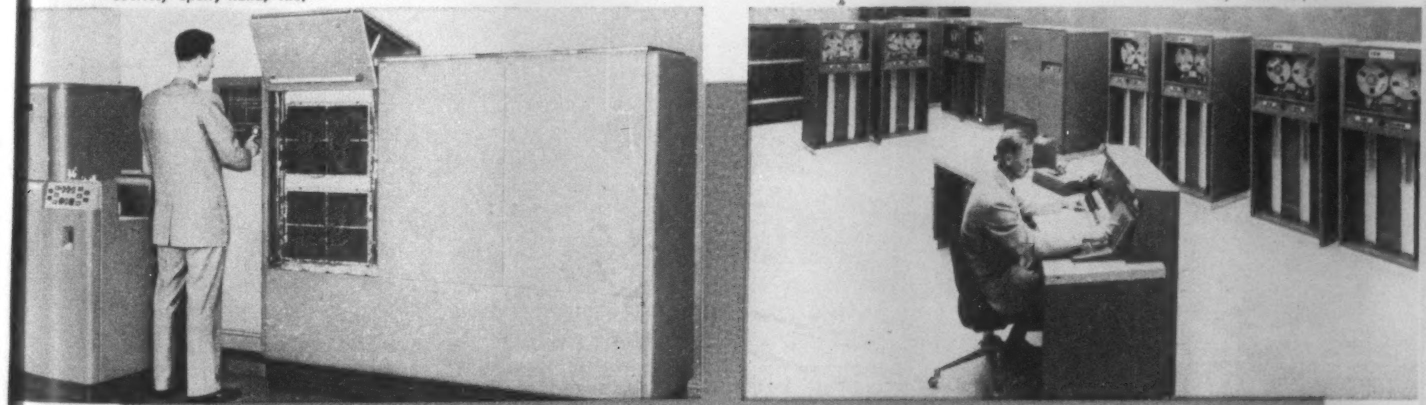


Fig. 4—Central file-maintenance and report-processing devices range from electronic calculators for use with data stored on tabulating cards, UNIVAC 120 left, to high-speed systems using magnetic tape storage, IBM 702, right. The correct computing facility must be chosen for the volume and complexity of work to be done

with an input or criteria in the form of policies and budgets, information on actual performance and on external conditions, and the ability to issue orders so that proper activity in his area of control will take place at the right time to correct deviations from the desired results.

Since the executive must exercise control so as to keep the system stable and meet the criteria as closely as possible, he must have rate-of-change and integral data just as in physical control systems. In order to provide such data the system must have a memory, which takes the form of files in business. Due attention should be paid to amplitude (volume) and phase (time) relationships as in any control system. Not enough is known as yet about the transfer-functions (input-output relationships) of the components to do this exactly, but some qualitative effects might be analyzed.

In addition to meeting legal and audit requirements, the major design problems then are: (1) How to transmit the input criteria to the controlling executive; (2) how to determine and provide the feedback data required by the executive; (3) how the executive should use the data to control the system (the decision-making process); (4) how to put these decisions into effect; (5) how to gather the feedback data; (6) what memory (file-system) is required; and (7) how should the feedback data be processed.

Since the business is a multiloop system, these questions must be answered for each loop, taking into consideration the interrelationships of the loops. At the present state of the art little more can be said about the utilization of this theory, but it is hoped that it will develop into a more useful guide.

Data Processing Job

The data processing part of the business control system, must provide data for various purposes in the proper form and at the right time. In order to do this it must have available the basic or raw data which can be obtained from the activities going on in the business. As we have said, many of the reports require summaries (that is the accumulation of data), and information about events which have occurred some time ago. Therefore the data processing system must have some way of storing or remembering the history of events in the business. This is done, as mentioned, by creating files.

Files are in a sense an analog of the business, and provide the data processing system with a source of information about activities without constant reference to the operating level—for example, determining inventory levels without counting stock, or determining what a specific employee worked on without asking the employee. Part of the data processing problem is to gather data from the activities and keep the files up-to-date.

This data must then be utilized after summarization and computation, to provide data in the forms required by reports, decision-aiding processes, or to issue orders. The final step in the process is to print (or plot) the data in a form which is most suitable for presentation to the appropriate persons. As a result of these requirements data processing falls into a series of processes of the pattern shown in *Fig.* 3.

Courtesy Telecomputing Corp.

Courtesy Hillyer Instrument Co.

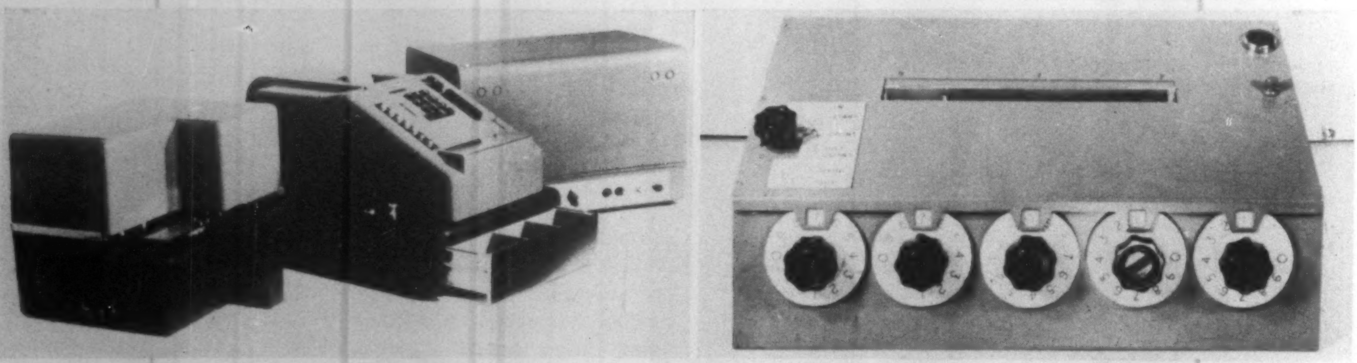


Fig. 5—Data gathering equipment is the most specialized of the business machine family, varying with industry and company. Point 'O' Sale recorder, left, puts data from a cash register and from pre-punched garment tags into paper tape, recording data in mechanized form at the time of the transaction. On the right is a device for recording transactions (job changes) in a shop. Order and employee data are read from cards inserted. Quantity is set by knobs. Data is punched on paper tape for later processing

▶ Data Processing Design

First step in the design process is to decide what files are required, and what data must be collected from the operating levels in order to maintain the files and provide information for the required reports, etc. Each business will have its own requirements for files, *Fig.* 4—companies making many products may have complex sales order files; companies providing only one service may have very small sales files. Nearly every company has employee and payroll files, but these may vary in complexity depending upon incentive plans used, and the different methods of paying involved.

There are no rules of thumb for selecting the arrangement of files for the data to be gathered and the reports which are required. Skill of the systems designer is most evident here. The type of equipment which might be used is also important. A manual system is, in effect, a system with a large number of relatively slow computers (people). In order to allow access to the files to all of them, it is usually necessary to have a large number of files sorted in various sequences.

With card systems, some consolidation of files is possible, since automatic sorters and other devices are available. The limitation of 80 or 90 digits per card makes separate files more convenient in some cases, however. With electronic systems which usually consist of one very fast computer, highly consolidated files are desirable. That is, as much information as is reasonable is put into one file (inventory files might be combined with requirements files and cost files) so that all up-dating and computation required can be made with one run through the computer.

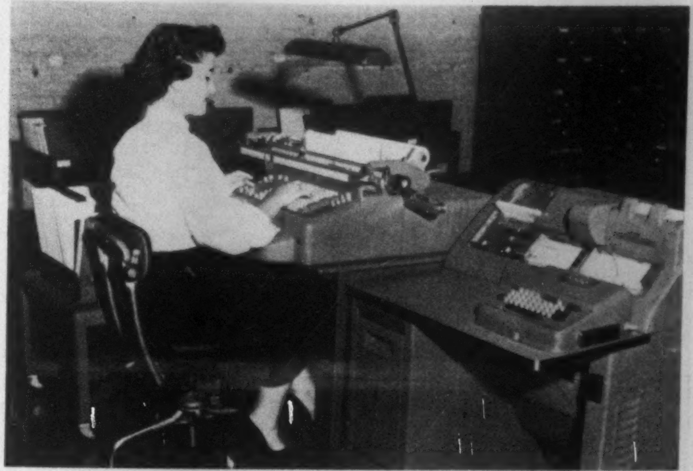
The result of this portion of the design effort will be a number of processes which up-date files and process the file data and incoming data to produce the required outputs.

▶ Data Recording

After the content of each file and process has been decided in detail, the required data must be gathered. The area of data gathering seems to have been neglected until recently, and as a result surprising cost savings can be effected by improvements here. Some rules for designing data gathering systems have been established.

It is desirable to record the data at the time the transaction or event occurs, *Fig.* 5. This will increase the probability of getting complete, correct data promptly. For example, when a job is completed in the shop, the report should be made immediately. When an order is received, it should be recorded and processed as soon as practical.

In mechanized systems, the data should be put into mechanized form at the time it is first recorded. Sometimes an attempt is made to prerecord data, for example to prepunch job cards. This technique often does not work in practice because conditions in most businesses change too quickly and a large percent of the prepunched data will have to be revised before it can be used. If, on the other hand, the data is not put in mechanized form until after the first recording then at least one manual transcription is required to go from the manual record to the mechanized record. This introduces errors, delays and higher costs.



Courtesy Systematic Bookeeping Machines, Inc.

Fig. 6—Typical special device, this unit couples a National Cash Register 3100 bookkeeping machine to a card punch, allowing the use of ledger-card files with bookkeeping machines for file maintenance. Subsequent processing, however, is easily performed on card calculators. The automatic conversion eliminates errors and wasted time. Good business systems engineers are aware of the possibilities of special devices such as these

Typical equipment for recording data so that it can be mechanized are: Typewriters, keyboards, bookkeeping devices, time clocks, etc., *Fig.* 6. Typical mechanized forms of recorded data are: Tabulating cards, punched paper tape, magnetic tape, magnetized cards, etc.

Use of an oral intercommunications system to transmit data from the place where the event occurs to a place where it is convenient to record data should not be overlooked. This is especially useful in gathering data from an extended operation where the events at any one place do not occur often, but in total a large number of events occur per hour.

Data should be checked as far as possible at the time it is recorded. Use of redundancy checks is convenient—more information than required is recorded, so that the data can be checked for internal consistency. Duplication of information is one redundancy method, although a somewhat expensive one. More sophisticated techniques are available wherein an extra digit is added to preassigned key numbers such as employee number, shop order numbers or sales order numbers. The digit is obtained from the basic number by a short computation which can be repeated whenever the number is rerecorded, and then the result can be used to check the number. The computed check digit will differ from that originally added to the number if an error has been made in transmission or in copying. A parity check is a redundancy check on binary coded information used in some computers.

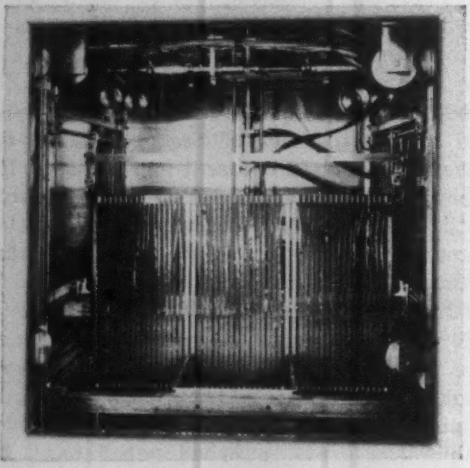
▶ Data Collecting

After recording the data the next step is to transmit it to places where it will be utilized. Usually this will be some sort of data processing center, but often the data will be used directly in other processes. For example, sales order data may be used directly to prepare the shipper, as well as in the preparation of sales statistics.

In transmitting and rerecording data on different forms it is most economical to use equipment with a common language. This means that the codes used for the data in the various devices and transmission media are compatible, and that media that carry the codes (paper tape, magnetic tape, cards, etc.) can be converted from one to another. It is possible to construct a device to convert from data in any code on any media to any other code and media. However, each conversion introduces the possibility of error and delay. As a general rule, therefore, the system should be designed with as few conversions as possible.

At this point it becomes important to recognize two types of file-maintenance systems, *Fig.* 7. In the first, called real-time or on-line systems, the initial recording of the data is communicated directly to the processing system, and the file is brought up-to-date within a few seconds of the time the activity took place. This type of system is especially valuable where the data must be used soon after it is recorded. For example, in the control of activities in a fabrication shop, where it is necessary to detect late jobs within hours, and where it is necessary to stop and change certain work immediately (for engineering or customer order changes) and therefore important to know at once the location of each job. In a real-time system it is possible to obtain prompt answers to questions from customers and management about the status of the work. The processing of sales orders in the wholesale business usually requires a real-time system, since the material must be shipped hours after the order is received. Thus all of the file-maintenance and accounts-receivable processing must occur within a short time.

A real-time system implies a random-access memory—random-access memory is one in which it is possible to read or write any item within a short time (from a few milli-seconds to a second). Ordinary tub files are one type of random-access memory. Other, more automatic types are now



Courtesy Potter Instrument Co.

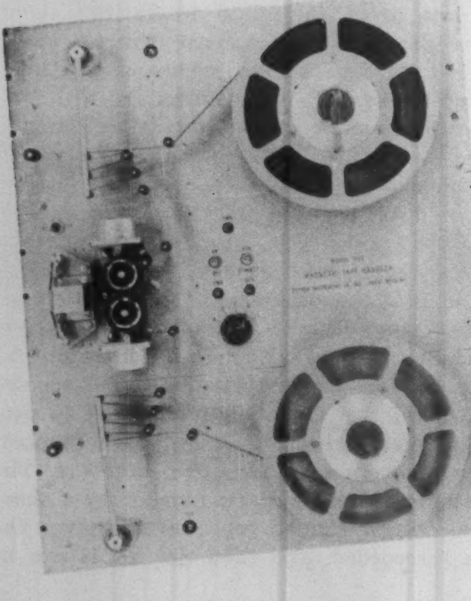
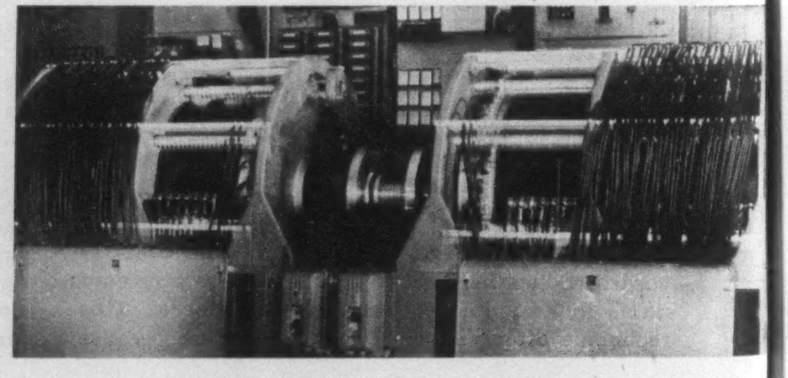
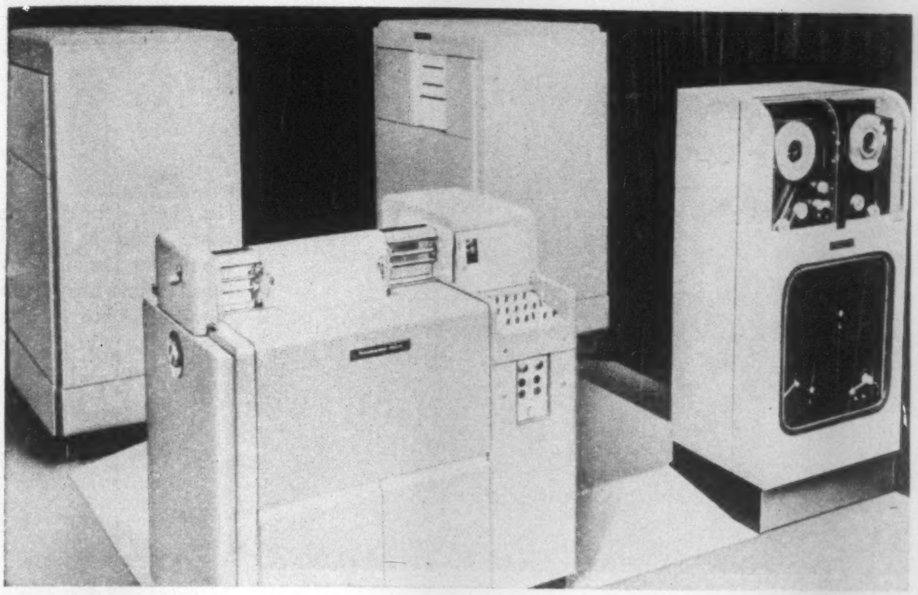


Fig. 7—Data may be filed on ledger cards (for manual reference), on tabulating cards, on drums, or magnetic tape. Upper photo is a picture of the American Airlines Resivisor drum used to store an inventory of passenger space available (on 1000 flights for 31 days). The center unit is a typical magnetic tape device for general purpose storage, (one million characters per reel). On the right is one approach to a random access memory: Rapid reference is made to the strip of tape containing the desired information. Complete system will hold 200 million digits

Courtesy Teleregister Corp.





Courtesy Sperry-Rand, Inc.

Fig. 8—Output may be through typewriters, card "tabs," or units such as this Remington Rand high-speed printer deriving data from magnetic tape. Units in the rear are power supply and electronic circuitry. This unit prints 600 lines per minute

under development (using magnetic disks, for example).

The second type of processing might be called delayed or batched or off-line processing. Most processing is done in this way because it is cheaper —especially with the automatic equipment available to date (cards and magnetic tape systems). In this system, records of events are accumulated into a batch. They may be accumulated for a few hours, a day, or several weeks, depending on the requirements for data and the processing cycle. Delayed systems usually imply a file in which the data is most easily reached in sequence as opposed to random references.

Whether real-time or delayed, computations required in file maintenance are usually quite simple —additions, subtractions, comparisons, etc. Much of the processing involves putting data into the proper arrangement.

▶ Data Disseminating

When the file system is established, the data processing system has the data necessary for preparing reports, processing data for decision-aiding methods and issuing orders. The processing for these outputs may occur at the time that the file is up-dated, or during a separate computing run. For example, in the wholesale business it is necessary to prepare shippers and provide data for accounts receivable at the time the file is up-dated in order to provide the required customer service. The preparation of statements from accounts receivable data could take place later, say weekly or monthly. Complicated statistical analyses of sales data are usually made on separate runs. The data for daily sales and cost-of-sales reports could be accumulated as the file is up-dated.

Although most computations for reports require simple accumulations, new management science techniques require more complicated computing procedures. Computing equipment should be chosen with this trend in mind.

Finally, having the proper output data available, it is necessary to choose adequate printing equipment, *Fig.* 8. Good estimates of the number of lines to be printed per day make the choice of printing devices relatively straightforward. The possibility of plotting data directly from the data processing system should not be overlooked, as plots can provide management with data in a form easy to interpret.

Every company whether it has 50 employees or 20,000 has a data processing system of some sort. An engineering approach to the design of the system may result in significant savings for any company, even though the final system is just an improved manual system.

Engineering of extensive complex systems such as business data processing systems usually involves two phases: (1) Continual improvements in the existing system to eliminate bottlenecks and to take advantage of new techniques to reduce costs; (2) conversion to a basically new system (decentralized to centralized, introduction of a tabulating card or electronic system). Improving a system usually involves redesigning a subsystem. and the engineering approach is still effective. It is important when redesigning a subsystem to determine the effect on the overall system so that the result is actually an overall improvement and there are no adverse effects due to unforeseen reactions on other parts of the system.

Whether making improvements or considering a basically new system, the first step is to obtain a clear picture of the company's data requirements. Then a good systems engineer should be put on the job, for it is the know-how and experience of the systems engineer which will insure that the most economic system is used to meet the requirements.

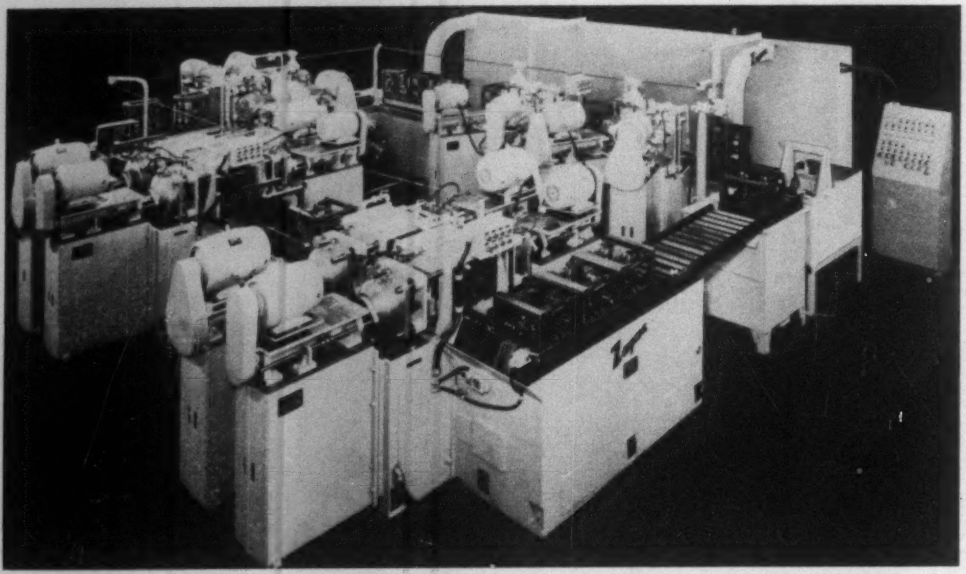
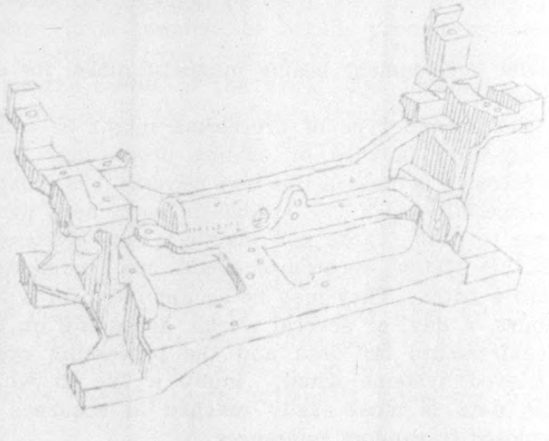


Fig. 1 — Transfer machine used to process typewriter frame castings. Pallets are loaded manually onto a roller conveyor which feeds the pickup station

TRANSFER MACHINE HANDLES TYPEWRITER FRAMES



HOW ACCURATE is the expression "Detroit automation"? While it is descriptive of the machine tools and transfer machines of the automotive industry, must we also infer that the ideas, systems and know-how are not adaptable to other industries?

Zagar Tool Inc., has designed and built a pallet-type transfer machine to drill, ream and tap different size holes at different angles—not in automotive parts, but in typewriter frames. The track is approximately 100 feet in length, arranged in a square. Frames are processed in 16 different operations including a washing and cleaning operation from as-cast aluminum die castings to finished frames ready for typewriter assembly. The machine, *Fig.* 1, has a total of 224 spindles and accommodates 26 pallets when fully loaded. Each pallet delivers two completed frames every 30 seconds.

After manual loading, pallets pass to the pickup station on a roller conveyor and then turn 90 degrees to feed into the first machine for drilling, reaming and tapping. Another turntable rotates pallets another 90 degrees for drilling and reaming on the second machine. A roll-over station positions the pallet on its side and a transfer bar moves it into the third machine for further drilling and tapping. Still on its side, the pallet is again turned 90 degrees for drilling, reaming and tapping at the fourth machine. After completion of all machining operations, the pallet is returned to its original position and then transferred to a wash station where it is submerged 18 times for complete cleaning.

The machine is electrically powered and hydraulically operated. Safety features include a pull cord extending around the perimeter of the machine so that the entire operation can be stopped from any station. Each station is equipped with a small control panel so that it can be operated independently for setup and maintenance. A control console indicates by flashing lights the status of every operation in the system, completely integrated so that no operation or movement will occur until every station has completed its job and is ready to accept more work.

A system similar to this has increased output of electric typewriters at the Poughkeepsie plant of IBM—"Detroit automation" in Poughkeepsie.

A BASIS FOR CONTROL—
CONDUCTIVITY DIFFERENCE

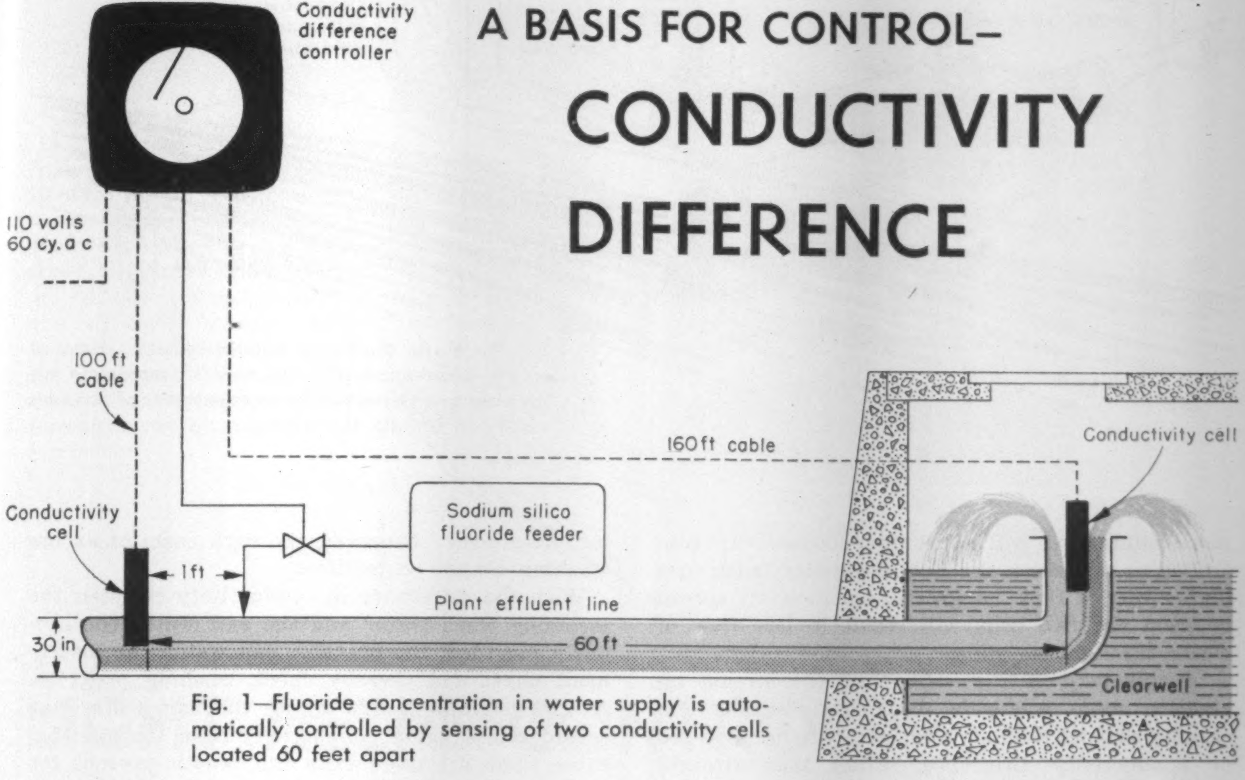


Fig. 1—Fluoride concentration in water supply is automatically controlled by sensing of two conductivity cells located 60 feet apart

CONTROL of industrial process water is of increasing importance to industry. Evidenced by expanding expenditures for control equipment, this widening interest in water control is caused by more critical process specifications, seasonal water shortages in some areas, punitive legislation aimed at preventing stream pollution, and probably the most important reason—economy.

Automation enters the picture in a number of interesting ways but principally in the form of automatic control of feeding equipment used to alter the chemical make-up of industrial process water and municipal supplies. This chemical alteration normally involves an electrolyte dissolved in the water; the result is a solution with a definite conductivity depending upon the particular substance dissolved in the water, and the concentration and temperature of the solution. A measurement of the conductivity at a fixed temperature is, therefore, a measurement of the solution concentration. Thus it can be seen that conductivity and especially conductivity difference affords a direct measurement on which control can be based. Conductivity difference as it is used here refers to the comparison of the measurement of two conductivity cells located at two different points in a flowing stream.

In one such application, fluorides are being added to a district water supply under automatic control, *Fig.* 1. Control of the rate of feed is based on the difference in conductivity between the treated effluent and the untreated supply 60 feet upstream. Whenever the fluoride concentration in the water tends to drop below the parts per million value set on the pneumatic controller, an air signal which is proportional to the actual fluoride concentration is transmitted to a pneumatically controlled valve in the discharge line from the solution pot of the feeder.

The wider valve opening admits a greater feed of fluoride to bring the system back to balance. Opposite valve throttling action takes place to prevent overdosing when water demand slackens. The recorder associated with the system indicates the actual fluoride concentration even if the feeder is prevented from supplying a sufficient amount of fluoride to maintain the desired concentration. The indicator panel also contains an alarm system which is actuated if concentration differs from the desired setting.

The Foxboro conductivity difference controller is also useful in preventing stream pollution, an all too common problem in industrialized communities. Where a stream varies widely in flow, due to rains or other disturbances, waste discharged to it from industrial plants can be controlled in relation to the capacity of the stream to absorb it.

The control system governing the rate of discharge is completely automatic, *Fig.* 2. One conductivity cell is immersed in the stream sufficiently above the outflow to prevent waste materials from reaching it by eddy currents. The other cell is located downstream at a point where mixing of the acid, alkali or salt-base waste is substantially complete. A decrease in conductivity difference will occur if an increased volume of flow dilutes the present quantity of discharge sufficiently or if the chemical properties of the discharge become

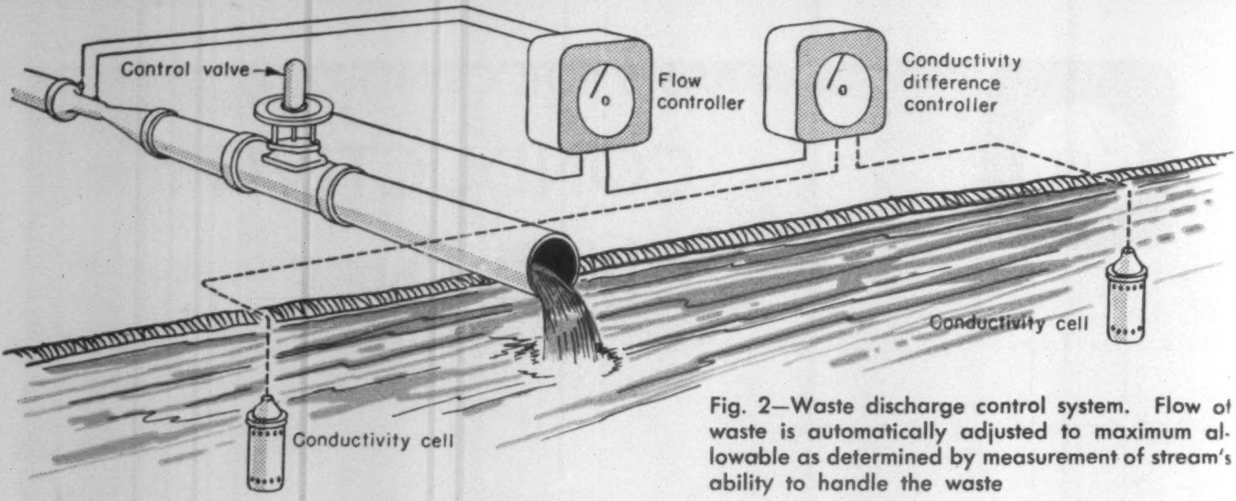

Control valve
Flow controller
Conductivity difference controller
Conductivity cell
Conductivity cell

Fig. 2—Waste discharge control system. Flow of waste is automatically adjusted to maximum allowable as determined by measurement of stream's ability to handle the waste

more dilute and will cause the conductivity controller to reposition the flow controller index to a higher rate of flow. A greater conductivity spread between the two cells will result in less flow of waste through the valve.

In this way, if the volume of the stream increases, more waste is discharged without exceeding official limits. And, with discharge based on conductivity difference, rather than straight conductivity measurement, any changes in the water from upstream causes will not affect control.

In-plant water handling is basically concerned with metering the service lines, conditioning the supply as needed, and governing its use during certain process operations such as washing.

Often the efficiency of a washing operation can best be gaged by conductivity difference instrumentation, *Fig.* 3. Here, in the processing of polymerized resins, it is essential to wash all but minute traces of caustic and other inorganic materials from the purified product. If impurities remain, they cause foaming in the kettle and priming in the overflow line, reducing yield and producing off-grades. However, the high costs of excess washing cannot be justified.

With the difference in conductivity between the incoming wash water and the exit water continuously recorded, the operator can watch the instrument chart and thereby check washing progress. At the beginning of a cycle, the exit water has considerably higher conductivity than the inlet because there are more salts and caustic present for pickup. As washing continues, the differential decreases, approaching zero at the end point of the wash cycle.

Conductivity difference is used because it is independent of changes in total solids content of the raw water supply. Therefore, the record is always a direct measure of dissolved salts picked up from the resin being washed.

Significant as they are, these municipal and industrial applications are only partially indicative of the progress being made by forward-looking industrial waste and quality control supervisors in utilizing measurements of conductivity difference. The concept is a simple and natural extension of the demonstrated conductivity principle of measurement and control.

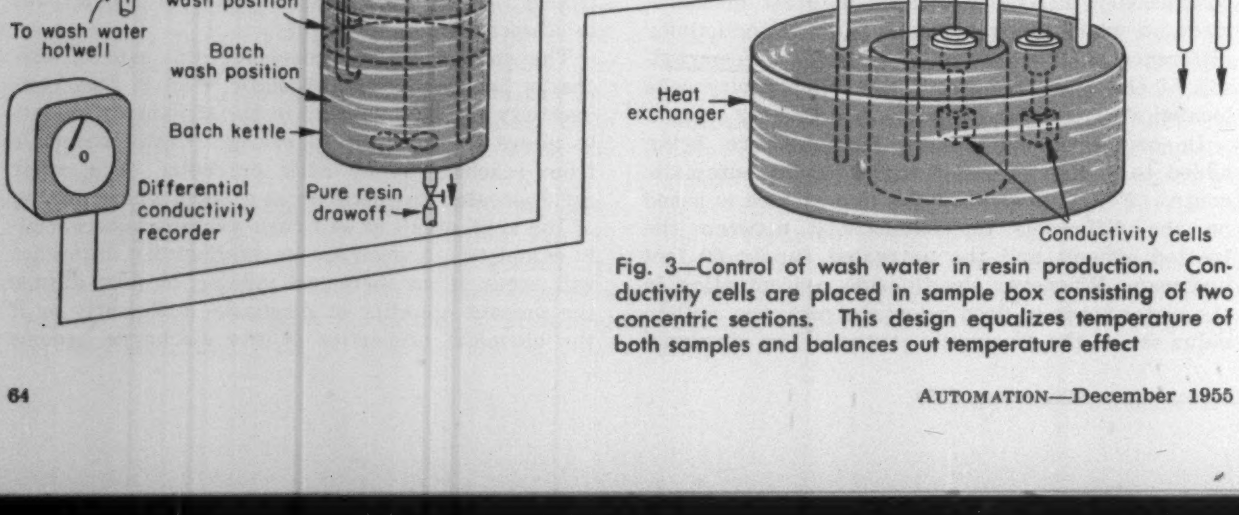

Air cylinder for positioning exit water line
Wash water in
Flexible exit hose
Agitator motor
Wash water inlet sample
Wash water exit sample
Decantation pipe
Continuous wash position
To wash water hotwell
Batch wash position
Heat exchanger
Batch kettle
Differential conductivity recorder
Pure resin drawoff
Conductivity cells

Fig. 3—Control of wash water in resin production. Conductivity cells are placed in sample box consisting of two concentric sections. This design equalizes temperature of both samples and balances out temperature effect

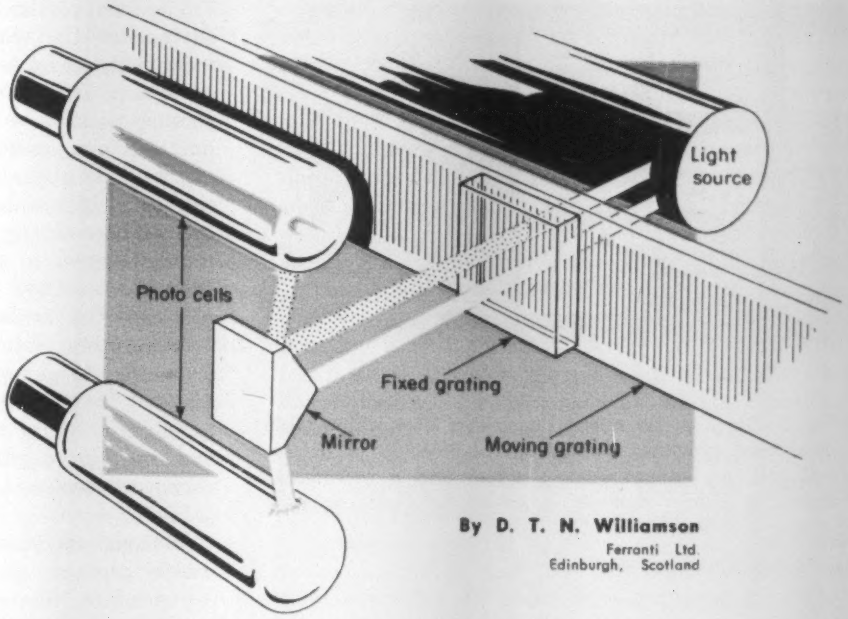


Fig. 1—Light directed through identical optical gratings can be sensed by one or more photocells. When one of the gratings is moved, the photocell will detect a cyclic variation of light intensity. By counting the number of cycles generated by a given movement, the length of that movement can be accurately determined

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LIGHT HELPS CONTROL MACHINING OPERATIONS

Tighter tolerances, increased volume, skilled worker shortages, need for better utilization of machine capacities—have all led to lively interest in automatically controlled machine tools. This article discusses some of the considerations involved and highlights a positioning system based on use of optical gratings

MORE EFFICIENT PRODUCTION of small lots is the goal of many people who are working on development of automatically controlled universal machine tools. It is known that existing types of machines are not as well suited as they might be to the economic manufacture of small quantities of components, tools, prototypes, etc. A major factor in this problem is the poor utilization of available capacity of manually controlled machines.

For instance, a man using a milling machine on a job similar to diesinking cannot possibly think fast enough to utilize the machine at a level remotely near its peak capability. Most of the manufacturing time is spent reading and interpreting drawings and transferring those data into the feeds of the machine—a process which is incredibly inefficient, involving as it does much redundancy, head-scratching and slow progress in order to avoid errors. The average feed rate (the total length of cut divided by the production time) is exceptionally low. Even the actual feed rate when cutting is in progress rarely approaches the optimum for the material being machined because human reaction time is far too slow to allow accurate control at these speeds. In manually controlled machining, much time is spent in altering the position of the work or the setup of the machine in order to machine contours, such as radii, which cannot readily be handled in rectangular co-ordinates and require the use of circular tables.

In its broadest interpretation the problem is one of feeding information in the simplest possible form into a machine which will interpret this information about the work to be done and produce the necessary tool movements. To meet this prob-

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Based on a paper presented at the conference of the Institution of Production Engineers, June 1955 in Margate, England.

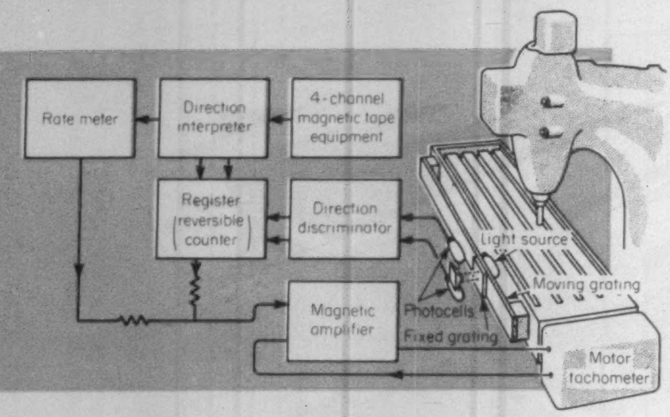


Fig. 2—Diagram for automatic control of machine table movement provided through a combination of a control unit, an optical grating sytem and a servomechanism to obtain motions specified on cards or tape

lem, computing and data handling equipment is available to produce control information of any desired degree of accuracy. But accurate control information is useless beyond the limitations of the measurement and control system of the machine slide. A reliable, accurate system to measure and control machine movements is thus a basic requirement for automatically controlled machine tools.

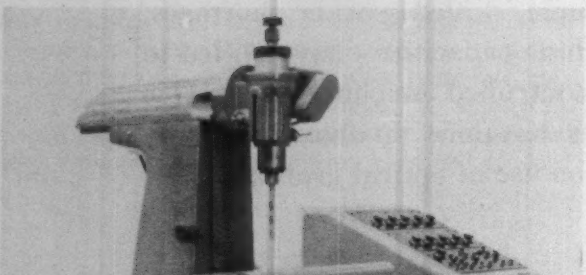


Fig. 3—Motions of this drilling machine are automatically controlled via magnetic tape by a system similar to that sketched in *Fig. 2*

The ideal method would be to measure the actual surface of the work as it is being cut. This is technically feasible for turned articles where the surface is available at a different position from the cutting position a very short time after it is cut, but it is not possible to do this in milling because the work is obscured by the cutter. The best that can be achieved is to measure the movement of the surface of the table, on which the work is fixed, relative to the main body of the machine. With this method the machine and tool deflection will cause an error, but this error can be reduced to a suitably low value by designing the machine correctly. In general the principle which has been adopted is that the measurement system should be slightly better than the accuracy to which the machine can normally work; thus any machine, taken as designed, is used to its maximum capability.

Various mechanical methods of measurement which produce an output for automatic control are possible. No great reliance can be placed on the use of a leadscrew as a method of measurement, although this is normally the only measuring agent fitted to machines. Problems of backlash and the compressibility of the oil film render such a system of small value where machining must be done to close tolerance by dead reckoning. Systems based on the rack-and pinion principle are troublesome where high accuracies have to be achieved, because of factors such as the presence of dust, variability of oil film thickness, tooth ripple and so on.

A method of measurement with none of these disadvantages has been devised utilizing optical gratings with a specified number of lines per inch. An advantage of this method (patent pending) is that the accuracy is unaffected by wear and can be made as high as desired. With a grating of 25,000 lines per inch it would be possible to discriminate between positions a few millionths of an inch apart; provided of course that attention was paid to all the other factors such as temperature, vibration and slide design which af-

DESIGN
Component is designed to be suitable for automatic machining

PLANNING
Job is planned and the co-ordinates of each point of change, the type of curve and tool feed and speeds coded on punched tape

fect such fine measurement. By the use of gratings with 5000 lines per inch it is a simple matter to position a slide consistently to an accuracy of 0.0001-inch, which is sufficient for all normal engineering processes and is better than the inherent cutting accuracy of most machines.

Both photographic and prismatic gratings can be used for this purpose but prismatic gratings have definite advantages when the number of lines per inch exceeds about 1000. Such gratings have not hitherto been manufactured in sections sufficiently long to be utilized for measurement, but for several years a process has been under development to make large prismatic gratings for spectroscopic purposes, and these gratings can now be adapted for measurement.

The method of utilizing the gratings for measurement is shown in *Fig.* 1. A suitable length of grating is attached to the machine table, and a short length of the same type of grating attached to the machine bed, so that one grating traverses the other with the two surfaces almost in contact. When a beam of parallel light is projected through the pair of gratings and they are suitably aligned, the Moire fringe pattern produced will modulate the light transmission when there is relative movement. One complete cycle of variation of intensity will occur for a movement equal to the pitch of the grating. By arranging two photocells so that the phase of this light variation is different in each photocell, a 2-phase electrical system can be formed. It is a simple matter to obtain from this system two or more discrete electrical pulses per grating line. The number of cycles or pulses generated in this system represents the distance moved; the frequency represents the velocity; and the direction of phase rotation reveals the direction of movement of the slide.

Use of optical gratings with automatic tape control systems for machine tools are illustrated in *Figs.* 2, 3, and 4. The block diagram in *Fig.* 2 outlines the servomechanism which translates the pulse trains from the magnetic tape reader into accurate slide movements. Considering one channel, the control pulses are fed to a direction interpreter, and according to the direction they represent, are passed to a register. This is a reversible counter with a small storage capacity, and it produces an electrical output proportional to the magnitude and direction of its contents. The control pulse train is also fed to a "rate meter" which produces an electrical output proportional to the direction of table movement and frequency of pulse repetition. These combined outputs actuate a high-performance secondary servomechanism that moves the table. A feedback signal from the table is obtained from a grating and direction discriminator, and the pulses from this signal are used to cancel the command pulses in the register. The system is so arranged that the error between the command pulses and the positional feedback from the table does not exceed one pulse.

Automatic control systems of this type must be engineered so that they are highly reliable and the occurrence of faults very infrequent. Circuit elements must be chosen which are known to be reliable. In the system described, the most frequently occurring elements are carbon resistors and germanium diodes. Circuits have been designed around these elements in such a manner that the possibility of failure is minimized. In industrial equipment of this degree of complexity it is of paramount importance to avoid circuits which have critical operating conditions or components. The use of automatic self-checking procedures is a worthwile step, and it is beneficial to carry out a marginal testing procedure each day, by reducing the supply voltages while a standard checking program is followed. Any circuit elements which are on the verge of failure are likely to be shown up by this method. In spite of preventive maintenance, failures of circuit elements may occasionally occur and it is essential that they can be located and replaced rapidly to avoid any dislocation of production routine. The type of plug-in construction shown in *Fig.* 5 is particularly suited

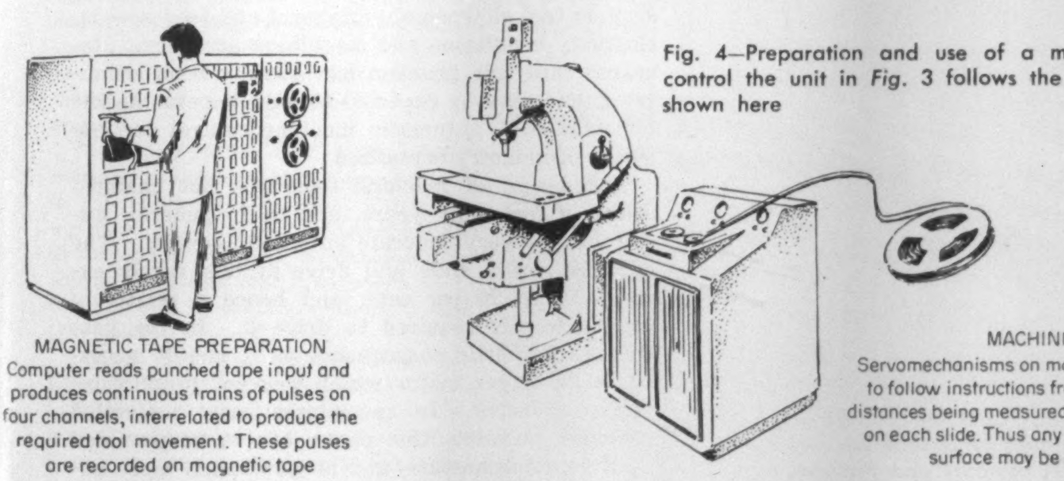


Fig. 4—Preparation and use of a magnetic tape to control the unit in *Fig.* 3 follows the general pattern shown here

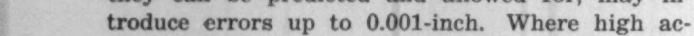
MAGNETIC TAPE PREPARATION
Computer reads punched tape input and produces continuous trains of pulses on four channels, interrelated to produce the required tool movement. These pulses are recorded on magnetic tape

MACHINING
Servomechanisms on machine move slides to follow instructions from magnetic tape, distances being measured by optical gratings on each slide. Thus any three dimensional surface may be contoured

to these requirements.

It is of course essential if a fault occurs in the control section of the equipment that the machine should cease to cut immediately, in order to avoid ruining the work. This can be done by arranging that signals from the registers, which reveal all deviations between the desired positions and the actual positions of the slides, shut the machine down if the deviations exceed certain predetermined limits. This deviation limitation is obtained with a combination of two counters covering the channels from the tape to a register and from the grating to the register, and can give a complete check on the behavior of the machine.

A tape control system using optical gratings as described has been in partial operation for several months. Preliminary results show that an overall accuracy of plus or minus 0.0005-inch should be achievable with good-quality standard machine tools, and that is sufficiently accurate for the majority of metalworking jobs. The limit of accuracy of plus or minus 0.0005-inch on a standard milling machine is set, not by the control and measuring system, but by deviations from perfection in the machine tool itself and by the physical nature of the cutting process involved in milling. The cutting tool and the material being cut are both elastic, and deflections and deformations are produced by the cutting stresses, which, unless they can be predicted and allowed for, may introduce errors up to 0.001-inch. Where high accuracy is required in milling, the technique of a roughing and a finishing cut is used. This can be achieved simply by running the program control tape through the computer twice; first with a figure for cutter diameter about 0.010-inch larger than is actually being used, and then with a figure for cutter diameter differing from the actual value by an amount indicated by previous experience to be sufficient to allow for the likely elastic deformation.



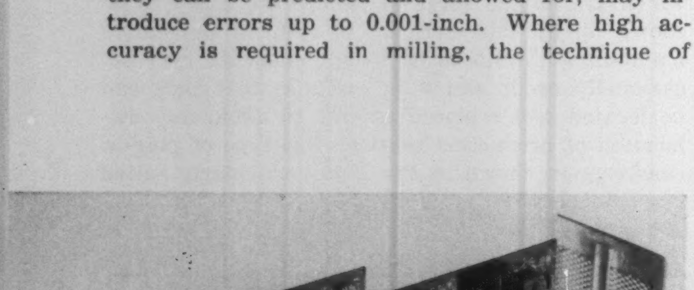


Fig. 5—This plug-in tray built for six "circuit cards" is used in the machine control unit pictured in *Fig.* 3. It is compact and provides ready access to circuit components

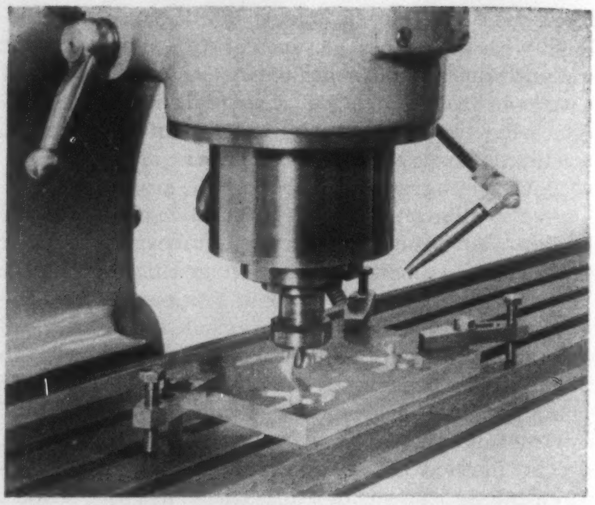


Fig. 6—Milling machines controlled by optical grating and servomechanism systems can produce parts even more complex than the waveguide type form shown on this machine

Errors caused by imperfections of the machine tool are mainly due to slide inaccuracies and play, lack of rigidity, backlash in the drive system and friction. Under normal running conditions, the grating measuring system will provide accurate positional information which will enable the servomechanism to correct errors due to backlash and slide inaccuracies.

The fundamentals of metal cutting are not completely understood and much more work is necessary to establish the relationships between factors such as tool sharpness, peripheral and feed speeds, elasticity conditions and machining accuracy. Research into this problem has already been stimulated, and may be expected to gain impetus as the importance of automatic machine control for the future of industry is realized.

The design of machine tools has not changed radically for many years, and is, in general, unsuitable for very accurate automatic control. The efficiency of a slide and drive system rarely exceeds 15 to 20 per cent, and hence a relatively high power is required to drive it. In the past this was of little consequence as it merely necessitated a larger motor which was not proportionately expensive. In an automatically controlled machine, however, this power has to be provided by a servomechanism, and is very much more expensive per horsepower than before. In addition, servomechanism performance inherently drops as the size is increased, so inefficiency is dearly bought.

The use of elements such as recirculating-ball nut and leadscrew assemblies and bushings, spring-loaded to the level of the maximum loads to be encountered, can be made to give high efficiency and freedom from maintenance troubles combined with a degree of rigidity and lack of play and backlash unprecedented in machine design. Use of recirculating-ball nut pairs with special leadscrews, preloaded to the maximum table force of 500 pounds, has been markedly successful in a prototype automatically controlled milling machine. The transmission efficiency has been increased from 20 to 80 per cent while the backlash has been reduced to less than 0.0001-inch. Furthermore, this performance will not be subject to deterioration due to wear.

Two comparisons of manual versus automatic machining in actual practice indicate possibilities for greater utilization of machine capacity and to meet the growing shortage of skilled machinists. A three-dimensional cam for a turbine-blade miller, taking three weeks to make by manual control methods, can be planned, computed and machined in four hours, without the need for hand finishing. A milled-block waveguide structure, which consists of very accurate tracks machined in two mirror-image blocks, employs a skilled machinist for two weeks using a conventional vertical milling machine with a rotating head. To plan, compute and machine both halves on an automatically controlled milling machine takes one hour—of which the actual machining time is thirty minutes, being limited on the particular machine used, by the low cutter speed. With a high-speed routing head, the machining time could be reduced to ten minutes. A simplified example of this type of milling is shown in *Fig.* 6. This sample took six minutes to cut.

In addition to the applications just described, in which the machine table is continuously moving under the control of a magnetic tape, there is another important use of the grating measuring system on machines in which the table merely needs to be positioned. Jig-borers, drilling machines, capstan and automatic lathes are machines of this type. Such applications may be much simpler than the one just described, as it is necessary only to set up a number, corresponding to the desired dimension, on an electronic counter and to cancel this number by the count from the grating measuring system. Control of movements can be done by hand, or automatically by means of cards or tape. Great speed and accuracy are obtainable by this method, particularly when a pattern of holes has to be drilled on a repetitive basis as with heat-exchanger plates, gear plates, etc.

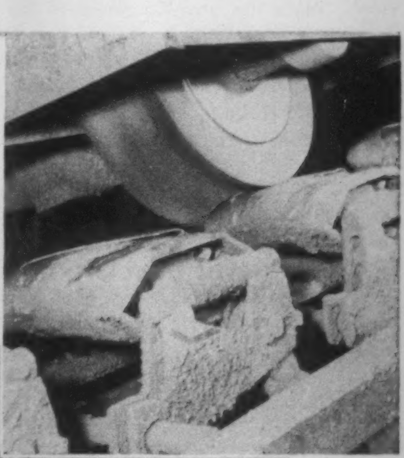
The development of automatically controlled machine tools outlined in this article is a practical reality and will find increasing application during the next few years. The advantages of these methods are not confined to large organizations and may actually be of greater economic importance to smaller shops to compete successfully in tomorrow's industrial markets.

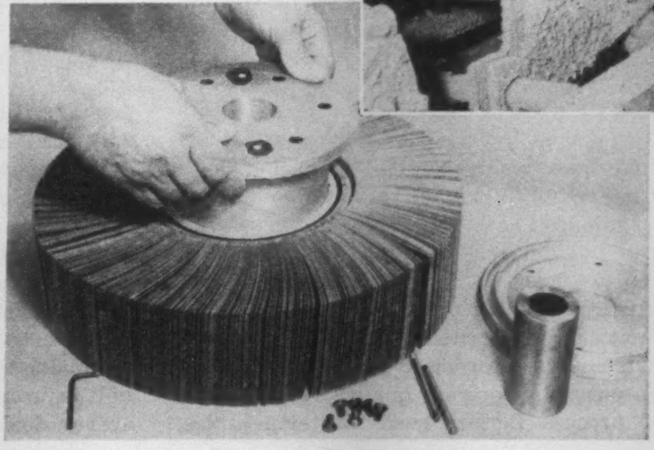
Polishing Wheel Holds Its Shape

NEW device for polishing metal has been developed by Minnesota Mining & Mfg. Co. All types of metal for plating, painting, or architectural finishing can be polished without the use of fine grit set-up wheels, rag or sisal buffs, or brushes. The device is called the "PG" wheel (polishing and grinding wheel). It consists of hundreds of pieces of cloth-coated abrasives factory-formed into a wheel that can be used on rotary or straight line automatics, or on standard lathes for hand operations.

The wheel differs from other products currently available, in that it removes stock as part of its polishing action. This abrading-polishing action and the wheel's ability to conform to the shape being polished enable it to remove mild draw marks in the same process in which it generates a buff-type finish.

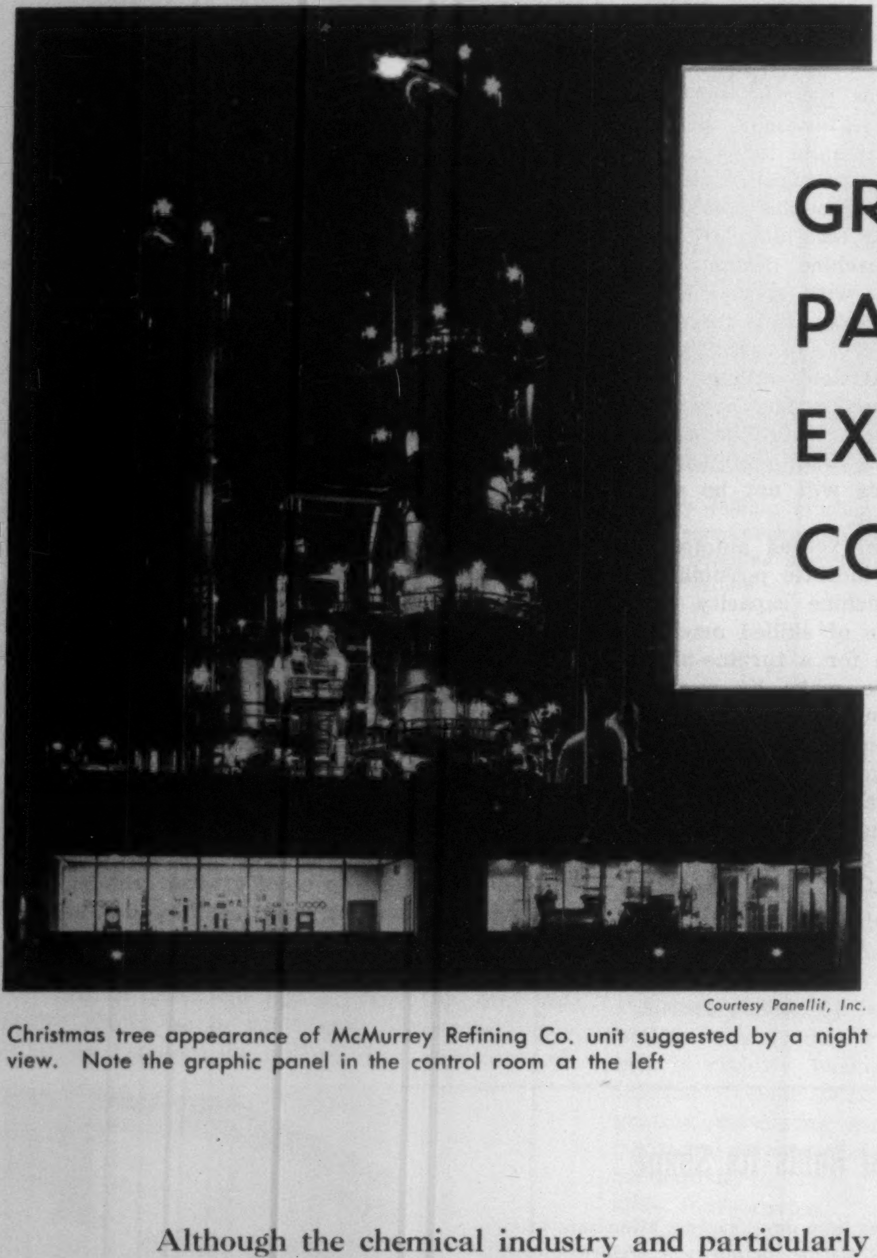
One of the major features of the new wheel is that its rate of cut and the micro-inch finish it produces remain constant from the beginning of a new wheel until it is worn down to the hub. It is not necessary to increase arbor speed to maintain the cut during the life of the wheel.





GRAPHIC PANELS EXPEDITE CONTROL

By **LEO WALTER**
Consulting Engineer
Cheltenham, Glos.
England



Courtesy Panellit, Inc.

Christmas tree appearance of McMurrey Refining Co. unit suggested by a night view. Note the graphic panel in the control room at the left

Although the chemical industry and particularly petroleum refining is considered to be highly automated, use of graphic control panels points up an ultimate controller—the operator

IN HEAVY CHEMICAL (bulk) manufacturing, various basic forms of automation have been used for many years. Several producing units have been joined by pumping a liquid or a gas from one unit to the next. Done automatically according to liquid level, gas pressure, or in relation to volume flow, this was the forerunner of automatic transfer. The process in each unit has been automatically controlled by means of a multitude of instruments in order to produce a uniform desired output of required quality. Automatic control of process factors such as temperature, pressure, pH, etc., has made each manufacturing unit more automatic.

Means of co-ordination and central supervision of each phase of manufacture is the job of the supervising engineer. Although after a number of developments it was found that control panels could be assembled in a central control room, the very complex processes in oil refining made it imperative to add certain facilities to the conventional instrument board. This led to the creation of the graphic instrument panel with which this survey deals.

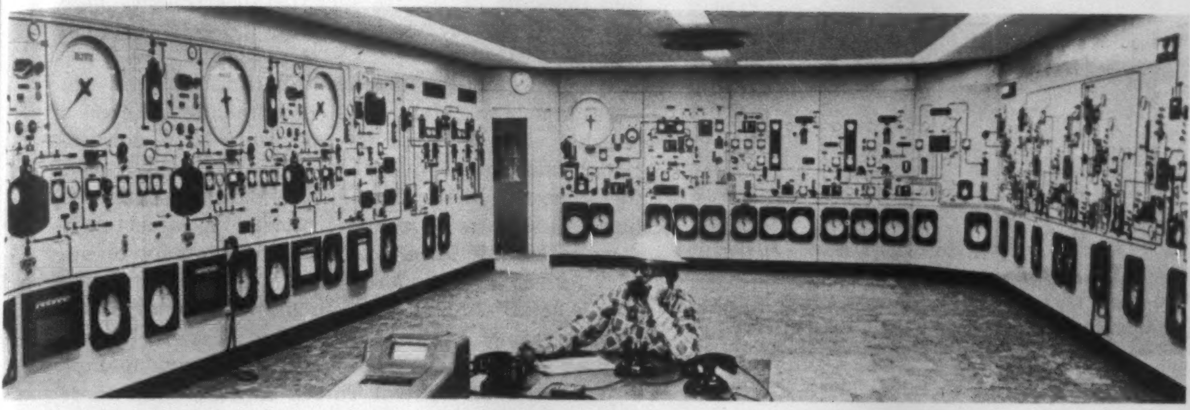


Fig. 1—Typical graphic control board installed by Panellit, Inc. in a chemical process plant of E. I. du Pont de Nemours, Inc.

Before going into a detailed description of graphic panels as used in the oil industry, in manufacture of heavy chemicals, *Fig.* 1, pulp and paper, and for power plant control, a few words might be said about the importance of graphic control panels for automation in general. Plants using graphic control panels are certainly anticipating automatic control, but they are not automatic factories in the strict sense of the word. Although supervision is centralized to the point that automatic scanning for disturbance causes can be set in motion by the control engineer, people have to be in the plant, either as workers or as auxiliary supervisors. Ingenious as the graphic panel is, it still has limitations inherent to any automatic control system in a plant. It is unreasoning, and if something goes utterly wrong, there is only one thing for the supervisor to do in the central control room—find out quickly where the disturbance has taken place in the plant, and switch from *automatic control* to *manual control.*

In the modern graphic panel, interlocking devices have been incorporated in the design to exclude as many human errors as possible in case of temporary hand control. Another safety precaution is use of annunciators which give a preliminary warning of excess values, and the like. These make centralized control by means of a graphic control panel as reliable as humanly possible but all this is not ultimate automation. Perhaps the day will come when oil cracking and other operations will be 99 per cent automatic—promising beginnings are visible in this direction. Quality and composition control by means of the mass spectrometer and infrared analysis will be followed by other rapid and continuous analytical measuring and control methods. Until then, and perhaps even then, graphic control boards fill a vital need.

Plant Control Rooms

In the development of increasingly complex processing equipment, a point was reached a few years ago where even the most skilled plant engineer and operator in certain chemical and oil refining processes could not possibly keep a close check on the many critical process variables. The problem was to make the needed centralized control panel economically feasible, and furthermore, to install all control and supervisory instruments

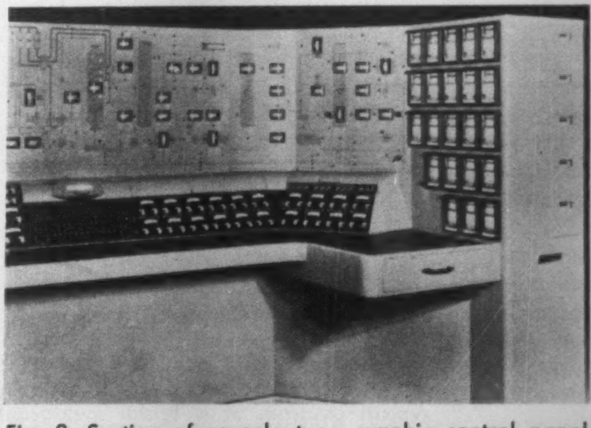


Fig. 2—Section of console type graphic control panel showing miniature instrumentation utilized in the flow diagram

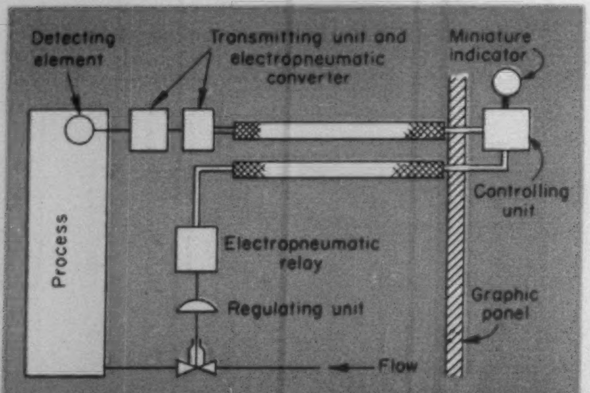

Detecting element
Transmitting unit and electropneumatic converter
Miniature indicator
Controlling unit
Process
Electropneumatic relay
Regulating unit
Graphic panel
Flow

Fig. 3—Electropneumatic control system utilizing electrical means for transmission, panel indicator and control, and pneumatic means for sensing and regulation

in a compact form, permitting the supervisor and plant operator to interpret quickly the instrument readings in terms of effect on the overall operation of several units of the manufacturing process. This called for a centralized control room with some new form of instrument control board which occupies less room than old established designs, *Fig.* 2. The tendency of instrument boards to become extremely inconvenient because of size spurred development of the graphic control board.

Any large panel which contains a great number of instruments, even if clearly designated, does not necessarily give an adequate picture of a complicated process flow line. Also, other incidental troubles are present. Distance-velocity lags have been introduced and in some cases, account for the major part of the total lag in the control loop. Then there is the question of personnel limitations, by no means the least important factor.

In considering these factors a worthwhile saving in space and cost must be achieved, an easily interpreted picture of the plant or process operation must be presented, and distance-velocity lags reduced to a minimum where their presence is detrimental to control.

To draw a clear demarcation line between applications for plant instrumentation where a graphic control panel is preferable to a conventional instrument board would serve no purpose, for it seems likely that future developments will increase the use of graphic panels. It is certainly very satisfying for the chief plant engineer or supervisor of plant operations to be able to walk into a small control room in his plant and to find the operating engineer sitting in a swivel chair making all his observations and necessary manual adjustments on control valves located somewhere remote in the plant from this central control room without leaving his seat.

▶ Instrumentation

In a modern graphic control panel, a primary need is for miniature instruments that perform four functions—indication, recording, integration and control. Systems used with graphic control panels are usually one of three types: Electronic, electropneumatic and pneumatic.

One obstacle in the use of electronic instruments for automatic process control seems to be the fact that the larger electrically-operated control valves, which may need to be very accurately positioned, are still under development. Electronic controllers, therefore, generally use pneumatically-operated

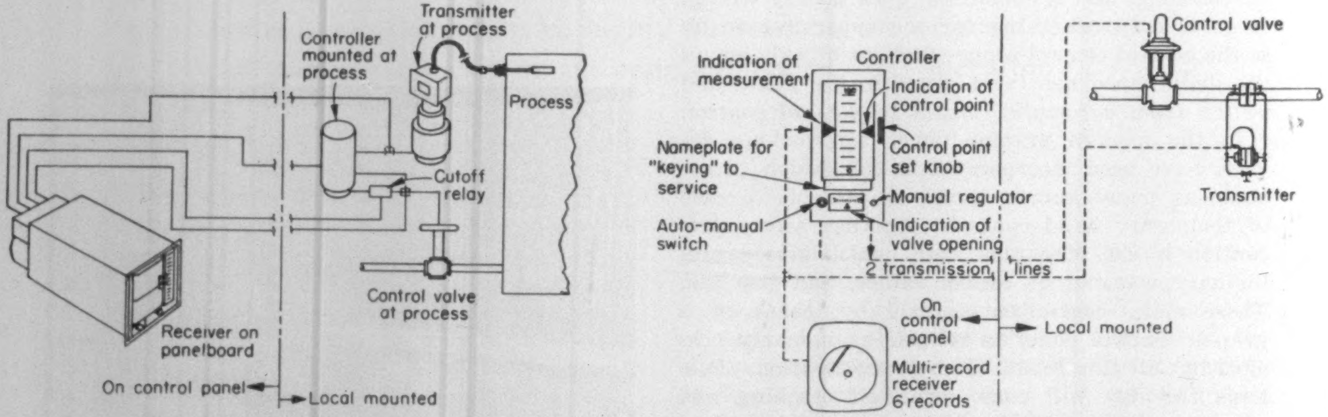

Controller mounted at process
Transmitter at process
Process
Cutoff relay
Control valve at process
Receiver on panelboard
On control panel
Local mounted
Indication of measurement
Controller
Indication of control point
Control point set knob
Nameplate for "keying" to service
Manual regulator
Auto-manual switch
Indication of valve opening
2 transmission lines
On control panel
Local mounted
Multi-record receiver 6 records
Control valve
Transmitter

Fig. 4—Diagrams of pneumatic control systems with controller mounted at the process, left, and mounted on control board, right. The process-mounted control system is a typical diagram of a Bristol metagraphic receiver installation. The panel-mounted control system features a Foxboro miniature controller

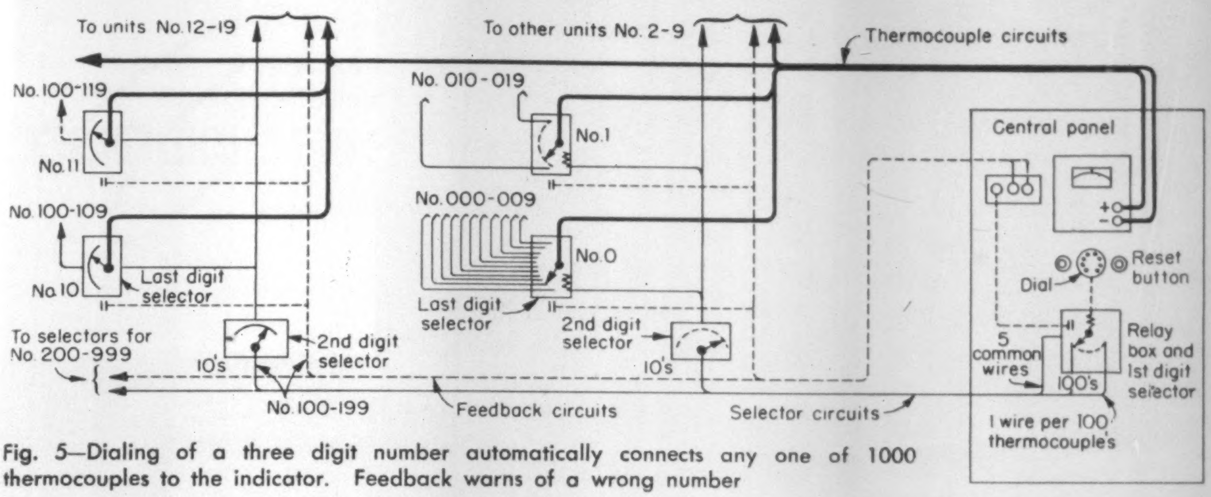


Fig. 5—Dialing of a three digit number automatically connects any one of 1000 thermocouples to the indicator. Feedback warns of a wrong number

control valves, and electropneumatic converters are installed in the control circuit.

As an example of an electropneumatic system, *Fig.* 3 shows the basic elements of an Evershed controller. Pneumatic systems with the control unit in the plant and with the control unit in the panel are shown in *Fig.* 4.

A more recent development in graphic panel utility is the addition of scanning instruments (such as television apparatus) which are automatically operated. Manually operated multipoint scanning instruments have been in industrial use for many years in the form of thermocouples to sucessively measure a great number of temperature readings by simply turning a selector switch. The development of fully automatic scanning equipment in conjunction with graphic panels now makes it possible to search a plant quickly for faults by simply pressing a button on the graphic control panel.

Various quantities to be measured and controlled (e.g. temperature, pressure, flow, liquid level, pH, etc.) are converted to electrical or pneumatic signals by means of a range of transmitters, which can be mounted either at the measuring point or at the control station. The choice between electrical and pneumatic transmitters rests on a number of factors, such as cost, explosion hazard and length of transmission line. Generally speaking, pneumatic transmitters are used in graphic control systems for all quantities except where long transmission lines would introduce serious lags into the control system or where freezing temperatures would effect condensate in pneumatic lines.

Diaphragm control valves are available for graphic panels for almost every application. Sizes from ½ to 8 inches are being made, and inner valves of V-port, characterized V-port, parabolic plug and proportional-uniform-percentage can be supplied in all sizes. Valve positioners or pilot relays ensure that the pneumatic control valve operates accurately at any output air pressure from the control mechanism. In an electropneumatic system,where electric control impulses have to be converted into varying air pressure, diaphragm control valves with converter relays can be used.

In recent times some new techniques have introduced the use of automatic scanners, annunciators, digital converters, and even automatic typewriters. These gadgets make possible the monitoring of hundreds of individual points during continuous processing. As the function of a well designed process monitoring system is to enable the plant supervisor and operator to pay full attention during normal periods to the entire system, some means had to be devised to facilitate quick and reliable tracing of any single cause of disturbance in the large process plant. As soon as any abnormality develops, it must be detected with utmost rapidity so that the process does not fall out of control.

In order to perform this very quickly, fully automatic temperature scanning systems have been developed which allow indication of process temperatures in rapid succession following the push of a button. Early scanners were equipped with standard roll chart or circular chart recorders, but modern scanning recorders have been specially designed. They operate at, say, two testing points per second, using a ballistic printing mechanism—a 576-point segmental recorder has been developed by Du Pont engineers, and has been constructed by Panellit. Large scanners have also been equipped recently with digital converting mechanisms. A standard tape recorder or automatic typewriter could be readily adapted to automatic scanning.

Another point of recent progress is automatic alarms or annunciator systems. Annunciators are operated by pressure switches which are connected to the controller output pressure in order to sound a buzzer. A process monitored in this way leaves the operator free to watch for disturbances at critical points. Standard temperature monitors are now available—among others—from

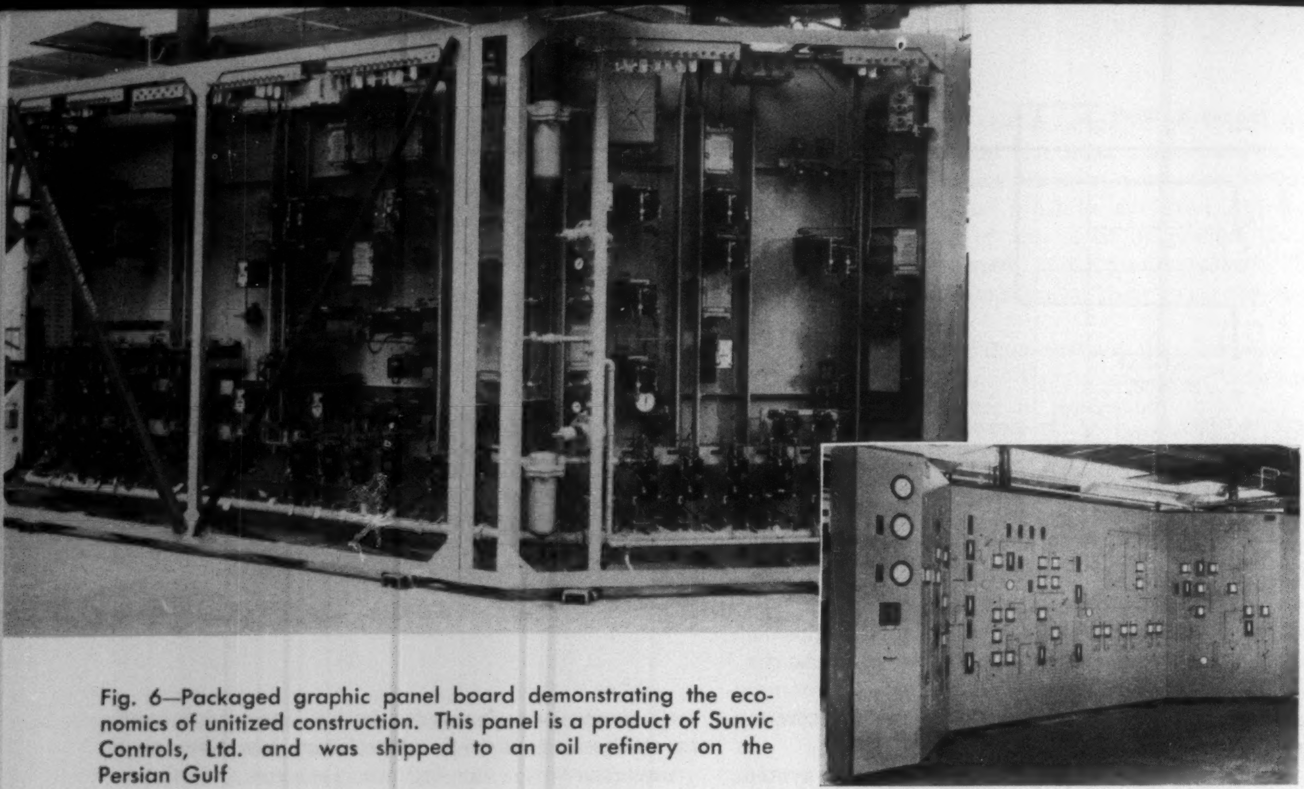


Fig. 6—Packaged graphic panel board demonstrating the economics of unitized construction. This panel is a product of Sunvic Controls, Ltd. and was shipped to an oil refinery on the Persian Gulf

Leeds & Northrup, and from Minneapolis-Honeywell. A stepping switch system has also been developed by Sun Oil Co. using a standard telephone dialing mechanism, *Fig.* 5.

▶ Economics

Contrary to the general belief that a central control room containing graphic control boards is more costly than when equipped with conventional control panels, it can be safely assumed that the overall financial expenditure will be about equal for both designs. Although development of a fully automatic plant would naturally have many more advantages than a centralized graphic control panel alone can claim, the incentives should be large enough to apply the graphic system of instrumentation in industries other than oil. A good beginning has already been made in the pulp and paper industry and in power generation.

Use of interlocked control instruments and of scanners and annunciators greatly increases safety in the plant. Uniformity of product and production costs in general is not credited solely to graphic control, neither is reduction of labor cost, since these savings apply to conventional centralized control in a lesser degree. However it is claimed by makers of graphic control boards that the use of prefabricated and completely wired units decreases overall cost, *Fig.* 6.

Among other developments of graphic panels, the semigraphic types prove very helpful in cases where the cost of a fully-equipped graphic control panel would be prohibitive. A small simplified flow diagram of the process, with signal lights and annunciators placed in the top half of the instrument board, and conventional instruments in the lower part of the panel often is adequate.

There are, of course, some difficulties with graphic panels—when a process has to be changed, rearrangement of instruments is difficult. As a whole, however, it seems that the future of graphic control boards in automation is bright, and that many central control rooms of the future will be based on process flow sheets with miniature controllers, recorders and indicators inserted at strategic points.

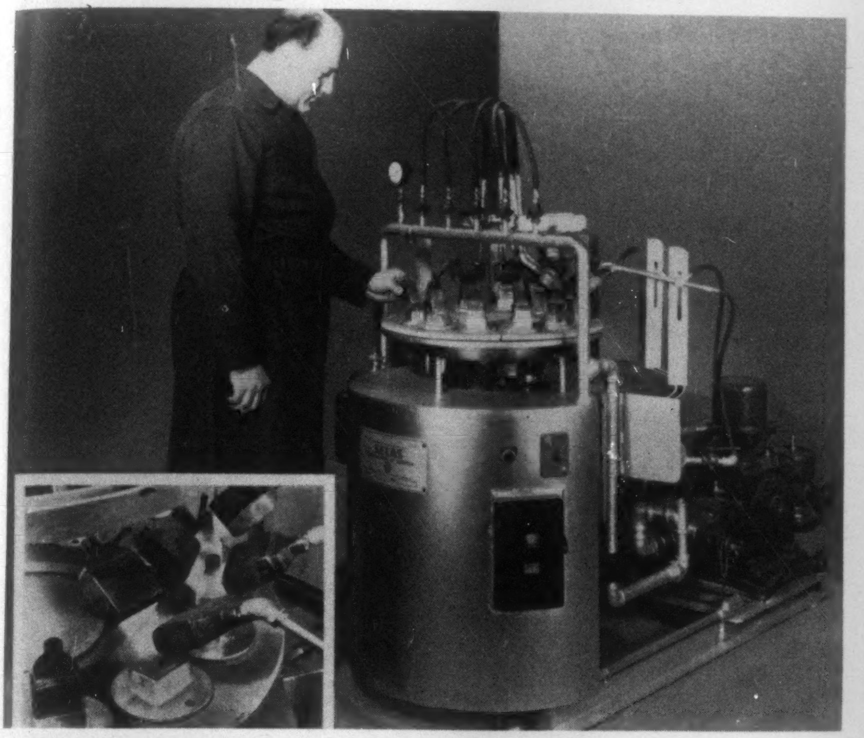
BIBLIOGRAPHY

1. "Graphic Panels" *Instrument Practice,* London, England, Sept. 1951.
2. C. H. Gregory—"Control Rooms for Chemical and Oil Plants," *Transactions of the Society of Instrument Technology,* London, England, Vol. 2, No. 3, Sept.-Dec. 1950.
3. E. P. Grace, Jr.—"Monitoring Systems that gather Process Variables at your Desk," *Industry & Power,* Oct. 1950.
4. C. M. V. Benwell—"The Development of Graphic Panels," *Transactions of the Society of Instrument Technology,* London, England, Vol. 6, No. 3, Sept. 1954.
5. W. T. Marchment—"Control Rooms for the Process Industries," *Evershed News,* London, England, 1954.
6. T. B. Jawor—"An Electronic Process Controller," *Power & Works Engineering,* London, England, March 1955.
7. John Madden—"A Graphic-Panel Centralized Control," *Instruments and Automation,* Vol. 28, Jan. 1955.
8. Albert F. Sperry—"Process Monitoring," *Instruments,* Vol. 26, July 1953.
9. E. C. Klepp—"Recent Developments in Instruments," *Journal of Institute of Fuel,* London, England, Jan. 1953.
10. V. V. Tivy—"Console-Graphic Panels," *Petroleum Refiner,* March 1950.
11. John E. Read and John Johnston Jr.—"Operation of a Semi-Continuous Process Using the Kinergraphic Control Board," *Instruments,* Vol. 8, Dec. 1952.
12. David M. Boyd, Jr.—"Process Control by Graphic Panel," *Instrument Society of America,* paper, presented at St. Louis, Mo., Sept. 1949.
13. W. T. Marchment—"The Application of Electronic Process Control to Oil Refineries," Instrument Society of America, paper, presented at Chicago, Ill., Sept. 1953.
14. Wesley T. Dorsheimer—"A Critical Look at Graphic Panels," *Chemical Engineering,* May 1952.
15. S. D. Ross—"The Graphic Panel," *Industry & Power,* Dec. 1953.
16. William C. Uhl—"Graphic Panels, the New Look in Instrumentation," *Petroleum Processing,* April 1950.

AUTOMATION

new equipment

Machines and plant equipment designed for more automatic operations



GAS-FIRED AUTOMATIC BRAZING DEVICE

Self-contained, gas-fired packaged unit automatically brazes small and medium size assemblies. Mounted on an integral structural steel frame, equipment in the package includes a combustion controller to deliver fuel/air mixture at a predetermined ratio and pressure, adjustable burners to provide the best heat pattern and heating rate, permanent or replaceable fixtures to support the work components, a dial type worktable to carry the assembly past the burners in continuous or intermittent motion, and necessary automatic timers, pneumatic indexing equipment and electric motors. Provision may be made for specialized functions such as automatic feed and delivery, and air or water cooling. Simple joints in small parts may be brazed by one operator at rates up to 500 assemblies per hour. Burners are adjustable to accommodate a variety of assembly shapes, and each can be turned off individually without affecting the operation of the others. Varying heat requirements may also be met by adjustment of the electric timer. **Selas Corp. of America,** Philadelphia 34, Pa.

Circle No. 1 on Reply Card

DEHUMIDIFIER UNIT

Adsorption type, heavy duty dehumidifier is suitable for use in factories, warehouses, storage vaults and other large areas where controlled humidity is desired. Automatically regulated dual-tower unit uses silica gel as drying agent. It is designed to maintain humidities as low as 10 per cent in areas up to 60,000 cu ft over wide range of temperatures. Machine has dry air output of 150 cfm and is capable of removing 4 to 5 lb of water per hour. Regeneration of silica gel is accomplished automatically by electric heating elements. Machine features motor operated four-way valve which alternately directs air from one silica gel tower to the other. As one tower is regenerated the other continues to dehumidify, thus providing constant flow of dry air. Additional feature is use of thermostats for control of regeneration cycle, thus making machine self-adjusting to atmospheric conditions. Unit requires standard electrical outlets and minimum of duct work. Built-in or remote humidistat control can be provided for complete automatic *On-Off* operation. Unit has applications in candy plants, refrigerated warehouses, dairies, fur and garment storage, electronic instrument areas, chemical laboratories, seed storage, and for rapid drying of plaster in building industry. It may also be used with air cooling equipment for low temperature, low humidity installations. **Dryomatic Corp.,** 812 N. Fairfax St., Alexandria, Va.

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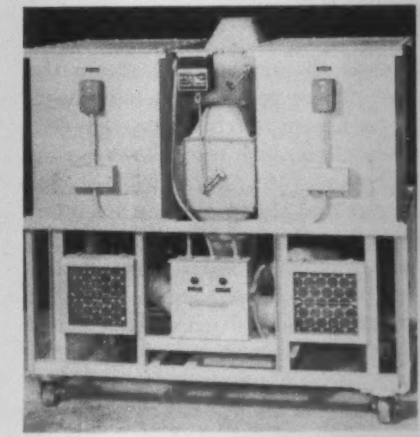
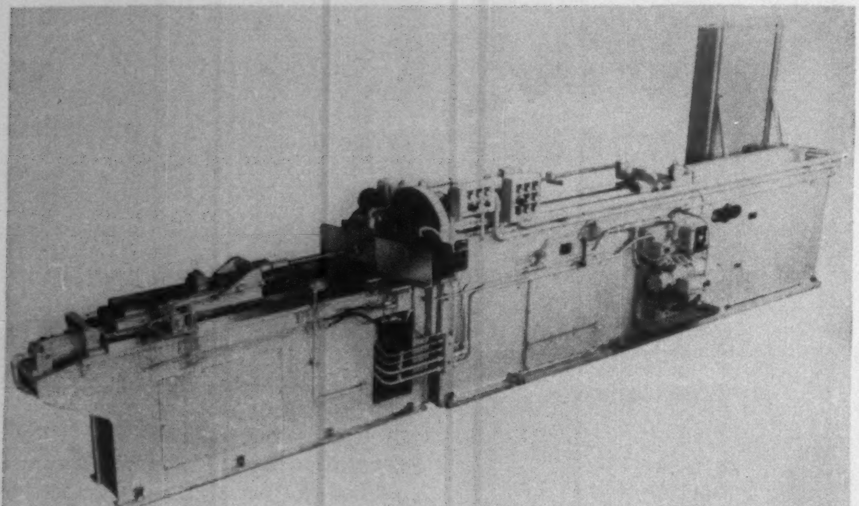




HORIZONTAL BROACHING MACHINE

Designed to fit in a conveyor line, automatic horizontal broaching machine with electrical controls broaches the inside diameter of laminated rotors for electric motors. Machine automatically positions, clamps, broaches and ejects the rotors one at a time. A sliding fixture with split V-shaped clamps is used to position and clamp the part. These vees retract individually to accept parts from the conveyor line and eject them after broaching. An automatic broach carrier and clamp mechanism interlocked to the machine cycle carries the broach forward through the part until it connects with the broach pull head. A hollow clamp nose on the carrier slides the fixture forward, seating it, and then clamps within the flanged rim of the part. Following the broaching stroke, a drag link in the carrier returns the fixture to alignment with the chute, allowing the part to be ejected. The carrier then moves forward to pick up the broach and return it to starting position. A universal chute, which can be adjusted to accommodate several different rotors, feeds the parts to the fixture. Retracting jacks in the chute are used to hold and release the parts one at a time. Operation of the cycle is completely automatic. The machine continues to cycle as long as parts coming in actuate the electrical interlocks. **American Broach & Machine Co.**, 415 W. Huron St., Ann Arbor, Mich.

Circle No. 3 on Reply Card

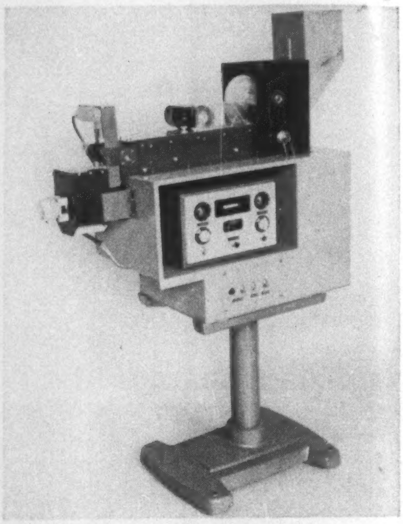
PUNCH TAPE UNIT

High speed, five-to-eight channel punched paper tape is created from modified adding machine by new automatic punch tape unit. Designed for integrated data processing, it perforates tape at rate of 20 characters per second. Electrical output adding machine with commutating mechanism is available in ten-key model and in two full keyboards, with eight and 11-column totalizing capacities. Tape punch can be operated by remote control with cable connection to adding machine. Error key which creates a coded signal on tape can be added to machine keyboard. Programming is dictated by uses desired of tape. Repeat entries can be coded into the programming. Power supply of punch unit is self-contained. **Electronics Div., Clary Corp.**, San Gabriel, Calif.

Circle No. 4 on Reply Card

COUNTING MACHINE

Universal machine automatically counts any predetermined number of items such as pharmaceuticals, screws, nuts, pipe fittings, and wide range of other small parts. It is unaffected by irregularities in shapes commonly found in such items as soft gelatin capsules and hardware. Changeover from one part to another is accomplished in minutes without additional tracks or other equipment. Machine can be used to count items for heat sealing wrapping machines, bottles, boxes or other containers. Portable unit is 55 inches high, occupies 3 sq ft of floor space and weighs 150 lb. Operation of equipment consists of placing items to be counted in hopper and setting desired quantity on electronic counting instrument. Machine then sorts, counts and divides objects into preset quantities. They can be either dispensed from machine as a batch or diverted singly through alternate chutes. **Delta Engineering Corp.**, 88 Broad St., Boston 10, Mass.



Circle No. 5 on Reply Card

AUTOMATIC WELDERS

Designed for hidden or submerged arc welding, line of automatic welders includes three new welding heads, new controls and adjustments, new accessories and two new power sources. Heads for either ac or dc current, field or shop welding, and constant potential or variable voltage power source are available. Operation controls permit choice of instantaneous starting, either hot for intermittent welding or cold for precision starting; choice of variable inching speeds, either slow or fast, away from or to work; and choice of carriage operation to give standstill starts, flying starts or manual control. Heads are designed to permit easy adaptation to fixtures, either as complete unit or as separate components. They can be universally positioned in any angle in three dimensions or off center for roundabout welding, and can be positioned on seam while welding. Either welding jaws or welding nozzle for more precise placing of flux can be used. Flux flow start or stop is controlled either automatically or manually. Electrodes in sizes from 3/32 to 7/32-inch are handled by one set of drive rolls, easily accessible through hinged door. Separate set of rolls handles 5/64-inch diameter wire. Roller bearing wire straightener with single adjusting screw can be swung 360 degrees about vertical axis to accommodate wire reels in any position. One power source gives 750 amp continuous duty ac power. Another power source available is motor generator machine specifically designed for automatic welding, rated at 750 amp, continuous duty at 40v. Other power sources available are 600 amp variable voltage dc motor generator and 600 amp dc engine driven welder for field operation. **Lincoln Electric Co.,** 22801 St. Clair Ave., Cleveland 17, O.

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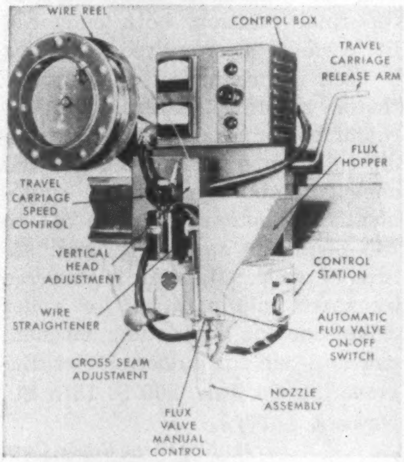
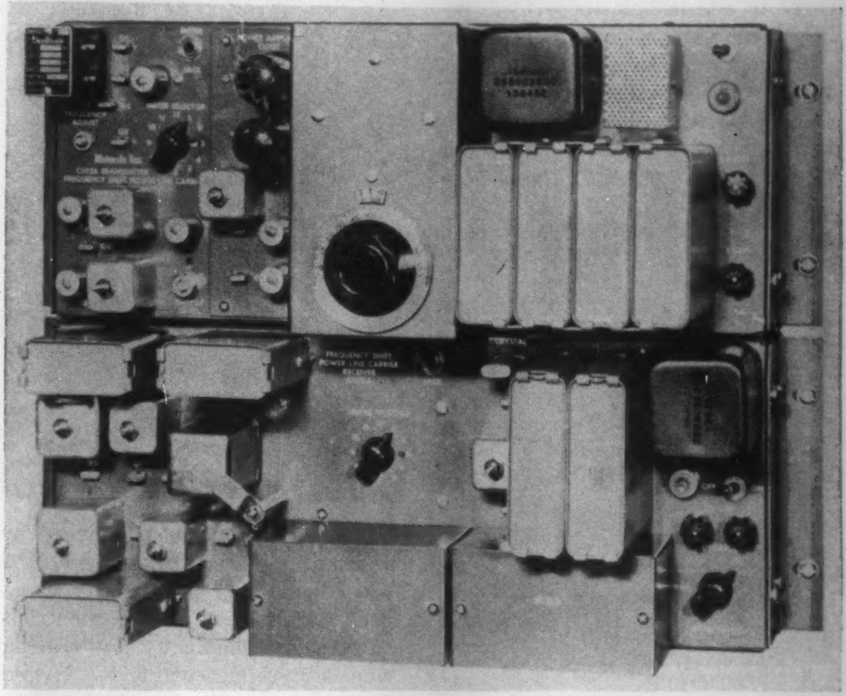




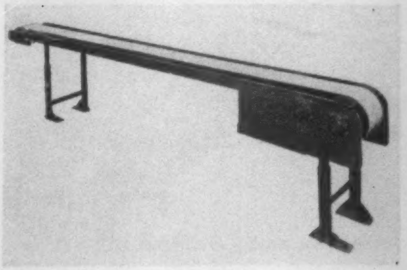
TRANSISTORIZED POWER LINE CARRIER

Transistorized power line carrier transmits information at the close channel spacing of 500 cycles throughout the 40-kc to 200-kc band. Receiver is completely transistorized; transmitter uses transistors for all but the power output stage. Use of transistors is said to provide a reduction in power consumption up to 75 per cent. Receiver consumes approximately 6 w. Push-pull circuit is used in the transmitter power amplifier stage. Frequency shift power line carrier is used to transmit telegraphic or other keyed type functions between stations on a power transmission line. Power line is designed for various methods of telemetering, load control, supervisory control, teleprinting, remote control and remote indication. In operation, an actuating contact shifts the transmitter frequency. Receiver detects this frequency shift and reproduces the opening and closing of the transmitting contact. Three types of information can be transmitted: Opening and closing of a single contact; position of a single-pole double-throw center-neutral contact, and alternating frequencies up to 100-cycles per second. Keyed functions can be transmitted at the rate of 60-pulses per second. **Motorola Communications & Electronics Inc.,** Technical Information Center, 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle No. 7 on Reply Card

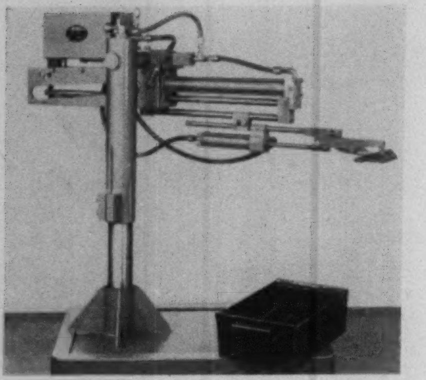
BELT CONVEYOR

Designed for production, assembly, inspection and packaging operations, horizontal belt conveyor is available in lengths from 5 to 80 ft. Frames are constructed of aluminum, steel or stainless steel in 10-ft sections. Conveyor belt can be lengthened or shortened by adding or removing these sections. Three standard frame widths are available: 12, 15, and 21 inches. Frame depth in work area is 2½ inches. Belts are of cotton, canvas, rubber, neoprene, plastic or wire mesh from 2 to 18 inches wide. Speed selector provides range of



three to one in belt speed by turning a knob. Standard drive is by electric motor and speed reducer. Wider belt speed ranges can be obtained with variable speed motors. **New London Engineering Co.,** 1700 S. Division St., New London, Wis.

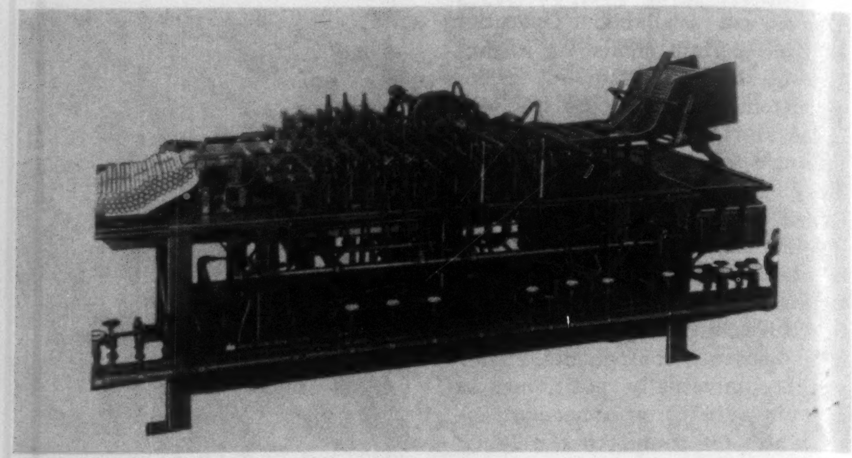
Circle No. 8 on Reply Card



PRESS UNLOADER

Swiveling unit for side or back unloading is feature of portable press unloader. Unit is well suited for job shop use because it can be moved quickly from press to press and is easily adjusted for different jobs. It can also be used with back geared presses where the gearing prohibits the mounting of standard overhead unloaders. Unit has same jaw, air cylinder and controls as standard overhead unloader used in automotive and appliance industries to unload large stampings. Unit is mounted on heavy steel base on wheels, and can be rolled to a press. There it can be adjusted up or down on its vertical post to suit the die height, and swiveled into unloading position. Since jaw travel is in a straight line, unloader can remove small parts at high speeds. In operation, jaw travels in and out on a straight line. After a ram completes its down stroke, hand moves into die and grips stamping. When it has clearance, jaw lifts stamping, moves back out the die and drops stamping in tote box. Then it returns to its original position to await next cycle. Variety of jaws is available. **Sahlin Engineering Co. Inc.,** P. O. Box 289, Birmingham, Mich.

Circle No. 9 on Reply Card



AUTOMATIC GLASS WORKING MACHINE

Among operations performed by automatic glass working machine are constricting or drawing a taper, cutting apart at the constricted area mechanically by cutting wheels or flame cutting by oxygen fires, flat or round bottom forming ball blowing any shape, glazing both ends and flanging or flaring either end of glass tubing. Fabricated table carries main bearings, hopper feed, glass forwarding mechanism and glass cutter. Motors and cam shafts are mounted underneath the table. Gas-air-oxygen manifolds with mixers and regulating valves for adjusting intensity of gas flames and one-shot lubrication system are located at front of machine. In operation, glass blank is carried from hopper feed automatically to several heating positions. In the constriction position, taper is drawn by powered driving rollers. In succeeding positions, glass is cooled or reheated depending on type of cutting (mechanical or flame cut). In the final position, both ends can be formed as required. Machine is used in production of hydromic floats, roasting basters, flat and round bottom vials, test tubes, radio tube bulbs, pharmaceutical and chemical laboratories glass equipment. Production output is 500 to 750 per hour depending upon nature of work. Machine is powered by three motors: one for roller drive, one for forwarding mechanism and one for cutter. **Eisler Engineering Co. Inc.,** 750 S. 13th St., Newark 3, N. J.

Circle No. 10 on Reply Card

DRAG FLIGHT CONVEYOR

All steel self-cleaning drag flight conveyor was designed to be a money and time saver. In one instance, belt conveyor replaced canvas model used to elevate and convey wet steel chips from automatic machines to gondola cars. New conveyor has each flight or bucket drag on steel pan when elevating. When it returns, it moves above the same pan, dropping any of wet steel chips or other material which might have stuck to flights, thereby reducing cleanup. Conveyor replacement problem, incurred through conveyance of abrasive materials, was solved. Another advantage was $1/3$ reduction in horsepower required to move chips. **Michigan Crane & Conveyor Corp.,** 113 N. McKinstry Ave., Detroit 9, Mich.

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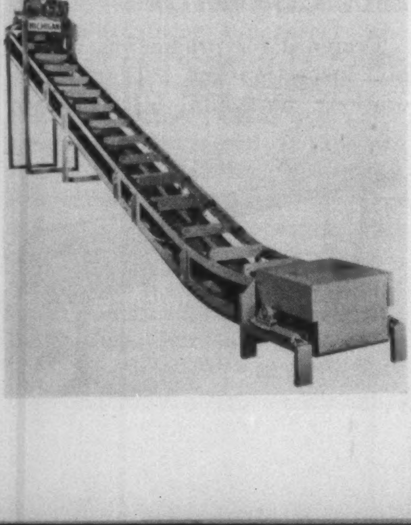

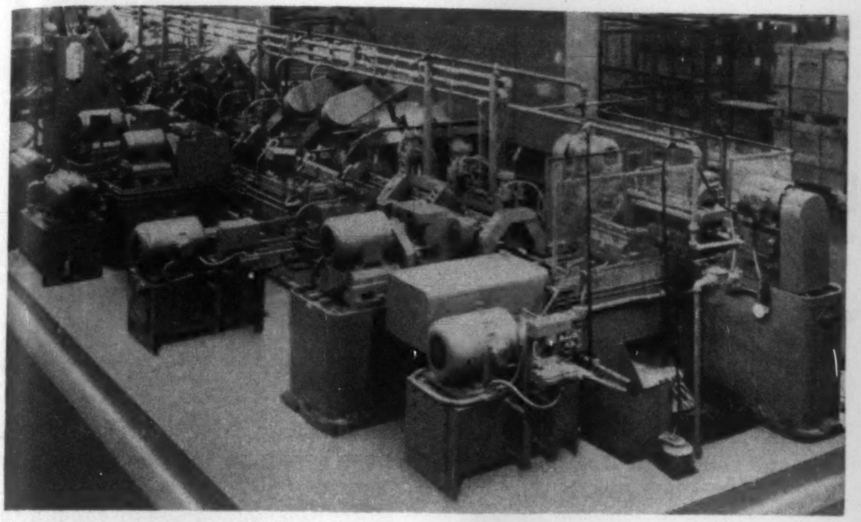

AUTOMATIC TRANSFER MACHINE

Designed for drilling, milling, reaming and checking operations on a V-8 engine rocker arm shaft, automatic transfer machine's complete cycle is 10 seconds with a gross production of 360 parts per hour. Parts are loaded into the pallet type workholding fixtures, positioned endwise automatically, and clamped with a power wrench. Transfer system is completely hydraulic, including the return transfer unit. Drilled holes are automatically checked at the next station and deburred at the last station after the milling operations. The parts are then automatically unclamped and unloaded on the return side of the machine. Machine has automatic lubrication, chip conveyor and pallet wash. **Industrial Metal Products Corp.**, Lansing, Mich.

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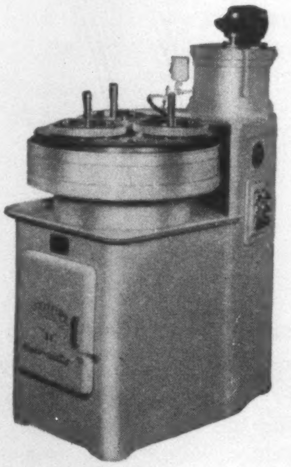


LAPPING MACHINE

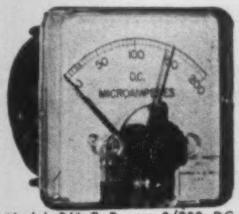
Completely automatic lapping to obtain precise finishes on small and medium parts are functions of lapping machine. Although operating on a pushbutton basis, new machine has adjustable eccentric motion duplicating figure eight movement used by master craftsmen in hand lapping. In operation, piece parts are positioned by laminated thermosetting plastic nests inside cast iron gear retainer rings. Parts are rotated clockwise against counterclockwise rotation of lapping plate, producing truing action and providing flatness of 1 light band or less to parts. Gear retaining plate is constructed with three hinged ports which swing out permitting gear retainer ring, nest and parts to slide off for quantity loading and unloading. Abrasive compound tank can be disengaged for cleaning tank, valve, feed line and visible sight gage. Built-in neoprene agitator constantly revolves to keep abrasive grit and vehicle in correct suspension. Ball bearings support lapping plate for uniformity of adjustment; all moving parts in gear box are permanently sealed and lubricated. **Spitfire Tool Co.**, 2931 N. Pulaski Rd., Chicago 41, Ill.

Circle No. 13 on Reply Card

(Advertisement)

METER-RELAYS

For Sensitive and Accurate Control



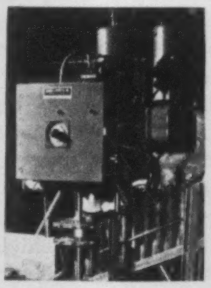
Model 261-C Range 0/200 DC Microamperes Price $33.00

RANGES:
0/20 Ua. to 0/50 A.
0/5 Mv. to 0/500 V.

The trip point is adjustable to any point on the scale arc. These meter-relays are sensitive to changes of as little as 1%. One contact is carried on moving pointer. The other is on a semi-fixed pointer. When two pointers meet contacts close and lock. Holding coil is wound directly over moving coil. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully. Three sizes of clear plastic case models, 2½, 3¾ and 4½ inches (all rectangular). Two ruggedized and sealed models, 2½ and 3½ inches (round metal cases). Contact arrangements: High Limit Single, Low Limit Single or Double (both high and low). Contact rating is 5 to 25 milliamperes D.C.

Suggested circuits for meter-relays and complete specifications including prices are covered in new 16-page Bulletin G-6, which you can get by writing Assembly Products, Inc., Chesterland 27, Ohio.

Atomic Exposition, Booth 423, Dec. 10-16, Cleveland, O



This B & R-engineered machine automatically fills fire extinguishers with CO_2 under pressure. Production is 15 times faster, accuracy much higher, according to Ansul Chemical Company.

Break production jams with special, automatic assembly machines . . .

engineered by

Barnes & Reinecke

Replace slow, costly operations with automatic, high speed assembly machines that keep pace with modern, automated parts production.

Special, super-accurate assembly machines, engineered and built by B & R, produce at fantastic rates. We'll engineer and build a machine to do anything you want it to do.

Let us show you what we've done, talk about your plant's production bottlenecks. No obligation, of course. *Write or call.*

Our 22nd Year

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230 East Ohio, Chicago 11 DE 7-6350

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

DENISON
LOXSWITCH
SNAP-ACTION

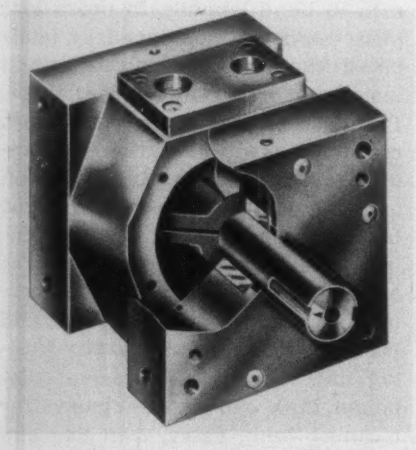
Machine Tool Switches

Featuring water-tight construction, line of machine tool switches is designed to withstand water, dust and oil even under severe operating conditions. An O-ring shaft seal, captive cover screws, watertight switch cover, and six back cover screws located at key points assure positive water seal. In addition, a glass fiber arc shield is used on switches for high arc resistance. Switches are made in a variety of styles which include: double-pole, single-throw, double-break; three-pole, double-break; double-pole, single-throw, double-break; neutral position, double-throw, double-break, normally open; and neutral position, double-throw, double-break, normally closed. All models have isolated circuits. Switches have contact units weighing only 2.45 grams (mass at impact) which combined with low impact and minimum bounce extend contact life. They also provide 70-degree safety overtravel without use of extra springs or cams, and are designed to provide interchangeability of mountings and levers. Switches are available with more than 150 lever styles, most styles with hardened pin and roller. **R. B. Denison Mfg. Co.,** 102 St. Clair Ave. N.W., Cleveland 13, O.

Circle No. 14 on Reply Card

Oscillating Torque Motor

Capable of obtaining up to 280-degree rotation, or oscillation, of a shaft for the purpose of turning, opening, closing, clamping, indexing, feeding, locking, pushing, mixing or moving any type load or mechanism, instant oscillating torque motor operates with equal efficiency on air, oil, water, or fire resistant fluid pressure mediums. Torque device eliminates complex linkage, gearing, transmissions, reduction gears, racks and pinions, levers, cylinders, cams, Geneva motions and clutches. Square-shaped unit requires minimum space in application. Mounting of motor can be made on any of the six faces of 14 mounting models. Four shaft style models are also available. With proper controls, rotative speeds of motor are limited only by fluid pressure volume. Torque of the device can be doubled while maintaining same exterior dimensions by limiting arc to 100 degrees instead of normal 280 degrees. Motor is available small enough to manipulate ounces, and large enough to move tons. Depending on lever arrangements, oscillating torque motor can be applied to industrial machinery, machine tools, construction equipment, materials handling systems and devices, and all types of processing equipment. **Roto-Mation Motors Inc.,** 525 S. Riverside, St. Clair, Mich.



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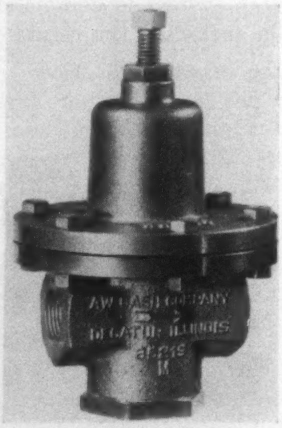

Pressure Regulating Valve

Water, gas, steam, air, oil and other non-corrosive fluids are among the applications of the self-contained, single seat pressure reducing and regulating valve. Unit operates within a range of 300 psi inlet pressure and 3 to 250 psi delivered pressure. Spherical self-cleaning inner valve and large built-in strainer are two features of valve which is available in aluminum, bronze, iron, steel or other specified materials. **A. W. Cash Co.,** P. O. Box 551, Decatur, Ill.

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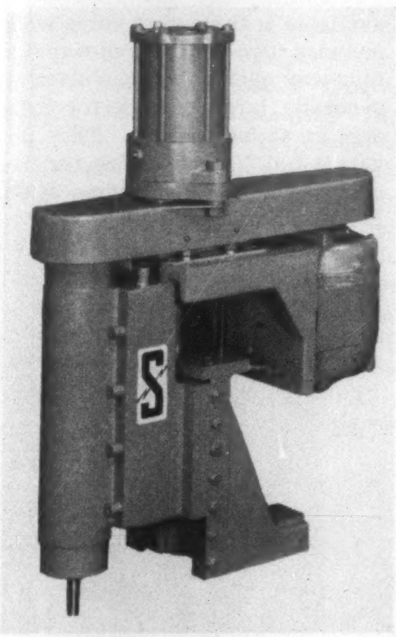
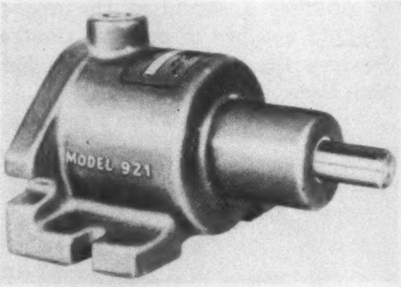


Reciprocating Precision Spindle

Precision spindle with belted motor drive is assembled as a unit on a vertical angle plate feed slide. Applications include a continuous wire brushing and grinding operation. Cyclical reciprocation of spindle is accomplished with an air or hydraulic cylinder asembled on a vertical angle plate equipped with composition (antifriction) ways. Numerous slides, feeds and tables available from company permit user to develop his own production unit, whether it involves single or multiple attachments. **Standard Electrical Tool Co.,** 2550 River Rd., Cincinnati 4, O.

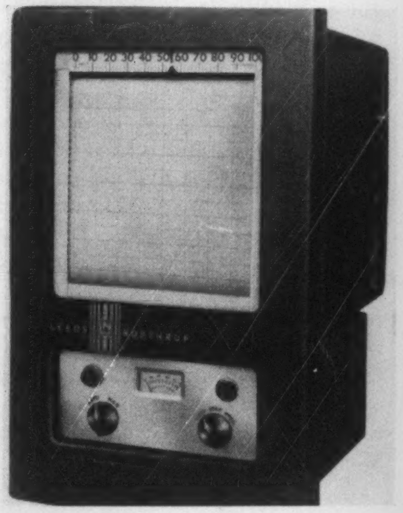
Circle No. **17** *on Reply Card*



Clamp Type Air Cylinders

Available in 2-inch bore size, 1 and 2-inch stroke lengths, new clamp type air cylinders have universal mounting. One-piece aluminum casting which has flat base for either horizontal or vertical mounting provides easy mounting or removal from jigs and fixtures. Holes are slotted so cylinder can be installed, relocated or removed by loosening hold-down bolts. Cylinder size is $4\frac{3}{4}$-inch for 1-inch stroke and $5\frac{3}{4}$-inch for 2-inch stroke. Unit is spring return type, normally retracted. Piston rod is $\frac{1}{2}$-inch in diameter and extends $\frac{7}{8}$-inch in retracted position. It is operated in Oilite type bronze bushing which is locked to prevent drifting. **Modernair Corp.,** 400 Preda St., San Leandro, Calif.

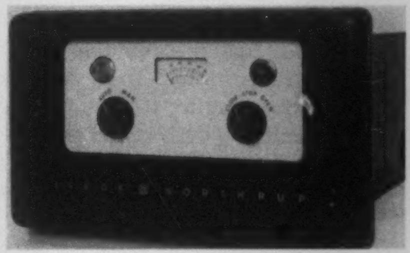
Circle No. **18** *on Reply Card*



Process Control Instruments

Line of control instruments consists of Type H controllers and Series 60 proportional control units. The controlling, recording, and indicating instruments are made in single-point for temperatures with thermocouple or "Thermohm" resistance thermometer as the sensing element. They have relatively long measuring scales and employ the full length in setting the control point. When used for on-off control, the controller is 11 x 12 x 11 inches, is available as a round chart, strip chart, nonrecording controller, or noncontrolling recorder. Unit controls by moving a fuel valve or contactor from fully-on to fully-off and provides simplest form of null-balance measurement and control. The proportional control instrument (illustrated above) measures 11 x $17\frac{5}{8}$ x 11 inches, and is available as a strip chart, round chart, and nonrecording controller. Fuel valve or contactor moves in proportion to fuel required for control, and instrument has three control options, depending on which of the three control units is used.

The control unit (illustrated below) translates the controller's measurements into the correct regulating operations between the controller and the fuel valve or contactor in a proportional control system. Three interchangeable types are available: position adjusting, duration adjusting (proportional, reset, and rate actions), and proportional control. Position adjusting unit is used when throttling of flame is necessary to control a fuel-fired process, when there is a substantial time lag before heat or load changes are sensed, when control point must be changed in the presence of large and frequent load changes, and when furnace pressure and/or fuel-air ratio require control. Instrument takes hold instantly when switched from manual to automatic control, and rate-of-approach setting, preventing overshoot, is automatic. Duration adjusting control is used when process is electrically heated or fuel fired and has on-off heat supply, when furnace pressure and/or fuel-air ratio are not controlled or protective atmosphere is not provided, when time lag of process, load changes and overshoot of control temperature must be overcome. Proportional action control is used when process is fuel fired and control must be maintained by throttling flame, when a substantial time lag before heat or load changes affects the process, and when load changes on a continuous process are small and infrequent. This control automatically proportions fuel across a band of from 0 to 10 per cent of instrument's temperature range. Reset



action is determined manually, and there is no rate action. **Leeds & Northrup Co.**, 4901 Stenton Ave., Philadelphia 44, Pa.

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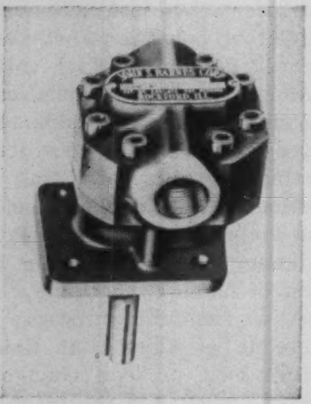


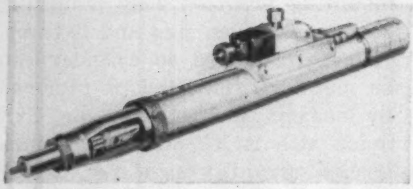
Hydraulic Motor Line

Deflector pin is centered in inlet stream of new line of hydraulic motors to reduce pocketing effect and increase efficiency. Better starting torque than is normally expected in gear motors is provided by modification to housing. At inlet side, material is removed to give clearance between first tooth and housing, permitting pressure to act on tooth with a maximum moment arm. Machining tolerances have been held to a minimum to increase efficiency and promote long life. Undersize bore and oversize shaft have reduced needle bearing clearances. Tooth structure fills mating space forming a seal and eliminating intermittent surge and vacuum conditions. Deflector pin has a minimum clearance with tooth tip. Designed for applications ranging to 2 hp, motor is also available with speed reducer drive to insure very slow speeds when necessary. **John S. Barnes Corp.**, Rockford, Ill.

Circle No. 20 on Reply Card

Automatic Tapping Tool

Featuring controlled thread cutting for high speed production of clean, accurate threads with minimum tap breakage, new tool is called the Airfeedtapper. Automatic tapping tool has adjustable torque control, enabling maximum permissible torque to be delivered to the tap for high output and low breakage. Adjustable feed rates permit advance to be set for best cutting with a particular tap size, while return can be set for a slower rate to prevent damage to entrance thread as tap is withdrawn. Microdepth adjustment permits Airfeedtapper to be used for blind-hole tapping. Advance can be held to within ¼-thread, and tap will automatically back out when desired depth is reached. Four-way valve, used to control tool from any remote station, makes Airfeedtapper adaptable to automation. Forward and return poppets are built into tool, making possible jog tapping when working on hard metals or compositions. Tool can be run to a stall and then backed out by pressing return poppet. Operation can be repeated until desired depth is reached, when Airfeedtapper will automatically back out and shut off. **Keller Tool Div., Gardner-Denver**, Grand Haven, Mich.



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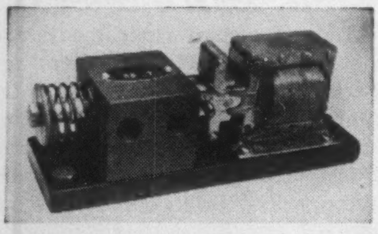
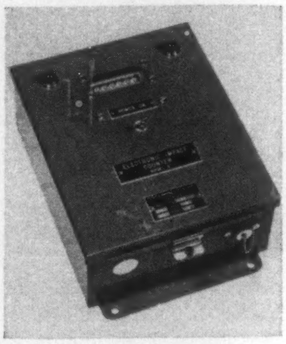


Plastic Control Valves

Designed for air, oil and other fluids up to 200 psi at temperatures not exceeding 200F, control valves feature resilient and sturdy construction. Plunger, which is hard-coated aluminum, is radially serrated. One piece body, machined from canvas base phenolic laminate, has annular grooves and neoprene O-ring seals. Valves are highly resistant to abrasive or corrosive conditions. Phenolic plunger can be furnished for specific applications. Illustrated valve shows the five-port model which provides four-way piped exhaust or double two-way action. Other body type available is three-port valve which includes two-way, three-way and four-way open exhaust. Valves are generally large enough for cylinders up to 5-inch bore. They provide a full ¼-inch orifice for fluid control. **John D. Bachman & Co.**, Bristol, Tenn.

Circle No. 22 on Reply Card



Impact Counter

Designed to count metallic or nonmetallic parts of any weight or size, new impact counter will handle rates up to 250 per minute. Typical applications include conveyors, loading devices, mechanical presses and other machinery producing parts. Counter is actuated by an impact accelerometer. The pick can be mounted on a baffle board, tote box or other receptacles into which the parts are falling. Counter is housed in a steel case with removable gasketed panel. Wheels of the six digit unit are visible through a plexiglass window. Neon light also gives count indication. Optional features include an external reset and preset counting to produce a signal at the end of a given number of counts. **Control Devices Inc.**, 8299 E. 9 Mile Rd., Van Dyke, Mich.

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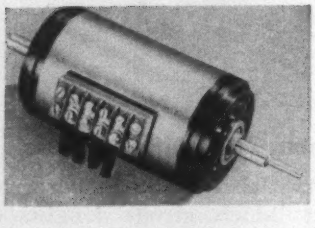

Magnetic Clutch

Electromechanical clutch is designed for servo system applications requiring the possibility of engagement or disengagement of either one or both output shafts from a single input shaft. This is accomplished by enclosing two magnetic coils and two sets of couplings in one housing. Functions of the shafts may be reversed so that outputs can be used as inputs, permitting the selection of either of two input rotations to be transmitted to a single output shaft. **Sterling Precision Instrument Corp., Instrument Div.,** 34-17 Lawrence St., Flushing 54, N. Y.

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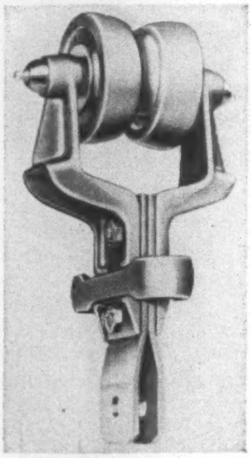

Trolley Conveyor Wheels

Designed for 4-inch I-beams, flangeless trolley conveyor wheels are grease lubricated and sealed against dirt. Wheels are of turned carbon steel construction, thoroughly hardened, and with precision ground raceways which have chrome steel balls enclosed in two-piece steel retainers. Curved tread. designed to center the trolley for line contact on lower I-beam flange, reduces friction and assures maximum load capacity. Wheels are also available with automatic lubricators. Trolley brackets have interchangeable parts and are easy to assemble in the chain. **Alvey-Ferguson Co.,** Dept. OTC, Cincinnati 9, O.

Circle No. 25 on Reply Card

Electronic Timer

Repetitive series of circuit closures can be produced automatically by cold cathode tube electronic timer. Load circuit remains closed for a fixed time of approximately 60 milliseconds. Time between circuit closures can be adjusted to any value from 0.03 to 24 seconds. Length of time load circuit stays closed can be increased by connecting capacitance to terminals. Hold-in time can be shortened by connecting resistance across terminals. Maximum current rating of 8 amp noninductive at 115v ac applies to two single-pole, single-throw contacts of timer. In addition to self-cycling feature, electronic timer features compact construction—3 by 3⅞ by 4⅞ inches. **Farmer Electric Co.,** 21 Mossfield Rd., Waban, Mass.

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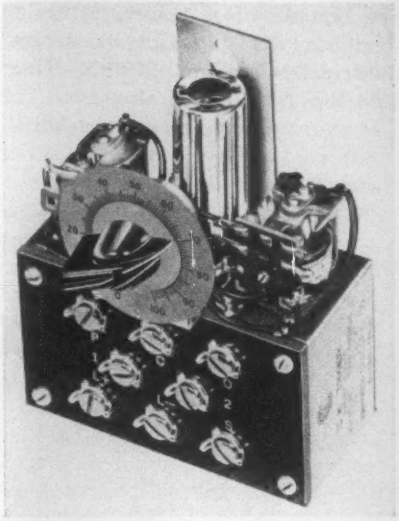

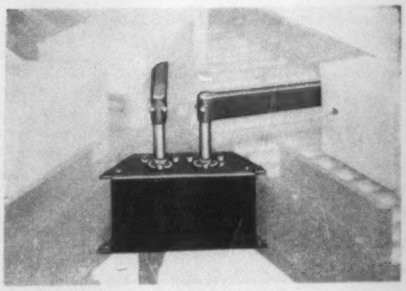

Conveyor Traffic Controller

Designed to handle a wide range of container types and sizes, traffic controller can be used with either belt or live-roller type conveyors. Unit regulates flow of goods from two merging conveyors and eliminates jamming at point of intersection. Traffic controller is mounted between two conveyors with steel arm extending across each unit. Article moving on one conveyor sweeps back the arm on that side, setting a mechanical interlock which prevents movement of goods on other line. When first line is clear, arm swings back, allowing goods on second line to flow to junction point. **Rapids-Standard Co. Inc.,** Dept. TC, 342 Rapistan Bldg., Grand Rapids 2, Mich.

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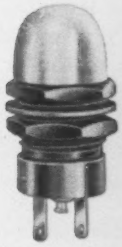


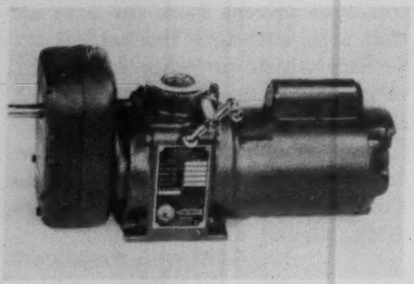
Sub-Miniature Pilot Lights

New series of two-terminal, subminiature pilot lights features all-directional visibility which is provided by stovepipe-shaped cap of high heat plastic into which bulb extends. Series mounts in single 15/32-inch clearance hole and requires no insulating mountings. Designed to employ any of five standard midget flanged base incandescent lamps of voltages 1.3. 2.7, 6.0, 14.0 and 28.0. Socket. lamp and all conections are insulated with phenolic material of military specification grade. **Dialight Corp.,** 60 Stewart Ave., Brooklyn 37, N. Y.

Circle No. 28 on Reply Card

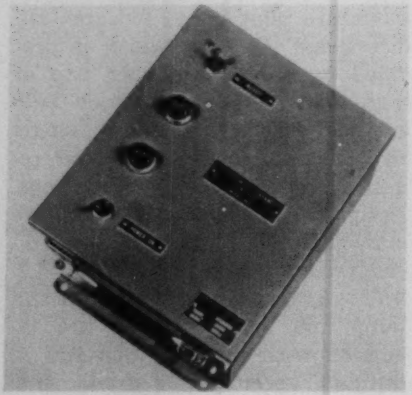
Variable Speed Transmission

Designed for high speed, wide range applications such as tachometer testers, small generator drives and test equipment, variable speed transmission will operate at speeds from 7500 to 0 rpm. Feature of unit which makes it well suited for applications mentioned is that torque delivered by transmission increases as speed increases. Accuracy of control is obtained over entire speed range through use of micrometer control, standard equipment with transmission. Drive will hold accurately at preset speed and may be reset exactly to predetermined setting. Entire assembly consisting of motor and



variable speed drive is compact and may be mounted with only four bolts. Transmission is available without motor or with many types of built-in motors. It is also available with variety of reducer assemblies for applications where wide range of accurate speeds are necessary at reduced top speed. **Graham Transmissions Inc.,** Menomonee Falls, Wis.

Circle No. 29 on Reply Card



Press Clearance Control

Designed to prevent press damage caused by failure of parts ejector, press clearance control is an automatic shut off which works from an impact accelerometer mounted on receiving tote box or unloading mechanism. If a part is ejected, accelerometer sends a signal to clearance control. Failure to receive a signal after each press cycle represents an ejection failure, causing clearance control to block next stroke. Action is so rapid that there is no interference with normal production unless a part remains in the dies. Two models are available, one of which is designed for use with presses equipped with electrical clutch systems. The other is used on presses which employ a mechanical or pneumatic clutch actuator. Both are housed in a heavy, oil-tight steel box with a removable cover. **Control Devices Inc.,** 8299 E. Nine Mile Rd., Van Dyke, Mich.

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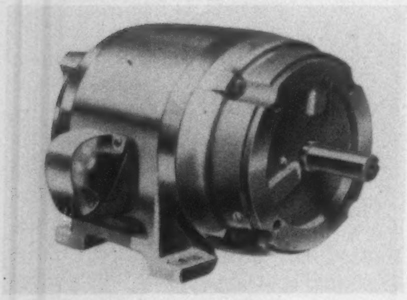
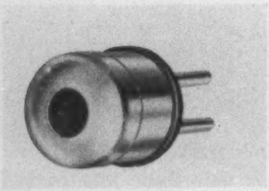


Horizontal Motors

Built to rerated NEMA specifications, line of horizontal motors has face type mounting brackets for direct connection to driven equipment. Motors can be connected easily and aligned automatically to the driven equipment. Brackets on illustrated model accommodate bolts from driven machine; other style permits bolting from motor side. Motors are available in ratings from 1 to 30 hp. Deflectors on units direct air and deflect water. Other features of motors are one-piece frame which is heat treated to prevent warpage, asbestos protected windings, and split type conduit box which may be located on either side of the motor. **U. S. Electrical Motors Inc.,** Box 2058, Los Angeles 54, Calif.

Circle No. 31 on Reply Card



Thermistor Heat Detector Cell

Remote detector of far infrared energy is designed for use in commercial applications of noncontact heat detection, measurement and control systems. Thermistor heat detector cell contains both active and compensating flakes. Performance varies according to flake size. Six standard flake sizes, special sizes and configurations are available. Characteristics for a 1 by 1 mm active flake are 3 megohm resistance at 25C, operating bias of ± 80v, time constant of 12 milliseconds. Sensitivity is 50v per watt when shunted by 3.3 megohms amplifier input impedance; spectral response is 1 to 12 microns with standard Serrofrax ® window. **Servo Corp. of America,** 2020 Jericho Turnpike, New Hyde Park, N. Y.

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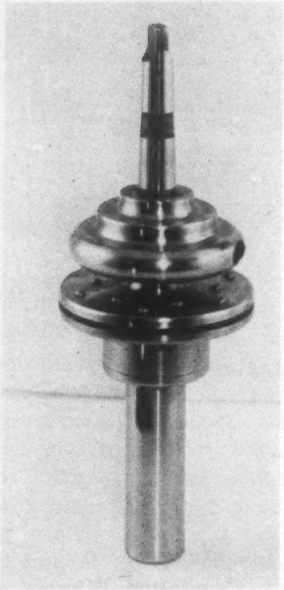

Constant Torque Couplings

Designed with automatic compensation for friction variation, torque controlled coupling delivers its torque setting with high accuracies. Coupling automatically adjusts the normal force between friction surfaces in inverse proportion to the variation in coefficient of friction. First, the torque compensation unit is adjusted to any predetermined torque using a standard Allen wrench, then checked with a standard torque wrench. Thereafter the friction plates are controlled automatically to supply an equal and opposite slip torque. Units may be designed into special tools, or directly applied as spindle or transmission type torque limiting couplings. Transmission type is furnished with an automatic tripper unit which actuates a limit switch that cuts off the power immediately when an overload occurs. Unit is available in five models from 5 to 1500 in-lb torque capacity. Body diameters range from 3 5/16 to 6½ inches. **Buffalo Machinery Co. Inc.,** 833-841 Grant St., Buffalo 13, N. Y.

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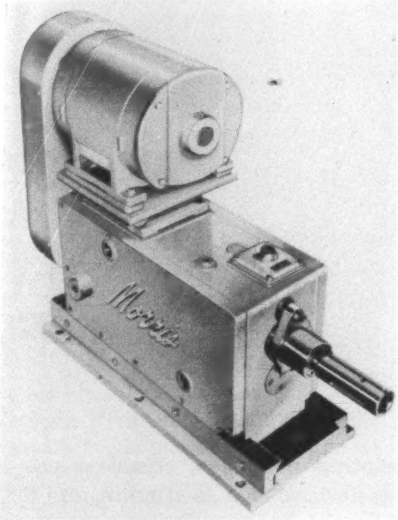
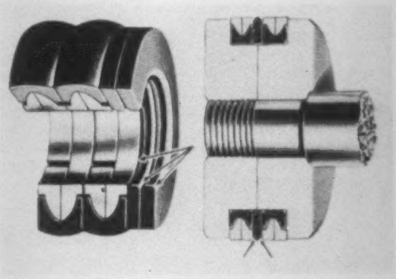


Cam-Fed Drilling Units

Automatic operation and variable thrust to suit the material being machined are the features of new line of cam-fed drilling units. Drilling, tapping, and allied operations, with automatically controlled operational cycles, are performed by the new machines. Units use an electric clutch in place of conventional linkages and power transmission devices. Adjustable rheostat permits sending varying amounts of current to electric clutch for effective adjustable thrust control. Amount of thrust required for a particular job may be dialed with rheostat dial. If the drill unit meets an obstruction, electric clutch will slip, preventing damage to the unit and to the workpiece. By adjusting rheostat for thrust just beyond maximum required for operation, it is possible to use electric clutch as a dull drill detector. When the drill becomes dull or is broken, clutch will slip, preventing off-size holes or poor drilling. Warning buzzer or light may be wired into circuit for audible or visual signal when drill becomes dull. Drill units utilize heavy machined cam to provide forward motion to the quill. Periphery of cam determines rate of quick approach, drilling time, length of stroke, and rate of rapid return. Units are automatically cycled. Mechanical devices, traveling with quill, trip limit switches to end cycle or to reverse quill travel and spindle rotation for tapping operations. Range of spindle speeds is between 20 to 1 and 1320 to 1 ratios to cam speed. **Morris Machine Tool Co.,** 933-17 Harriet St., Cincinnati 3, O.

Circle No. **34** *on Reply Card*



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ings. Called the Monopak, unit is designed for low friction and safety. Addition of chamfer on flat rings of Monopak eliminates ring extrusion and resultant braking action under heavy pressure. Design change also provides an efficient trap for any minute foreign matter which might escape rod cleaning device. **Hydraulic Accessories Co.,** 24301 Hoover Rd., Van Dyke, Mich.

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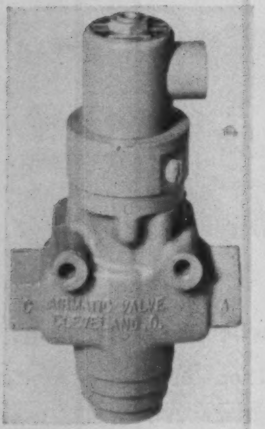

Pilot Operated Air Valve

Feature of three-way solenoid pilot operated air valve is positive bubble tight shut off and noncorrosive construction. It is adaptable to application on air clutches, air brakes, power feeds and other pneumatic equipment. Valve operates without springs. By rotating pilot head, valve can be used normally open or normally closed. Solenoid has a low amperage solenoid coil which operates on most ac and dc voltages (with power consumption of low maximum), and directs two internal moving parts—pool and solenoid plunger. Valve has full pipe capacity with operating pressure ranging from 30 to 150 psi. Lead lengths of 24 inches are provided. **Airmatic Valve Inc.,** 7317 Associate Ave., Cleveland 9, O.

Circle No. 36 on Reply Card

Control Relays

Designed to occupy minimum panel space without sacrifice of ruggedness and to provide an increase in ease of wiring and maintenance, line of 10 amp control relays includes relays with from two to 12 poles. Relays feature sectional pole design. Each pole is mounted in its own melamine block. Poles are individually removable and replaceable without disturbing other poles or other wiring. Another feature is that relays with up to eight poles are available without complicated wiring and vertical space requirements of double decking. Construction of pole blocks is such that each pair of contacts is contained in its own arcing chamber with melamine walls between poles, permitting relays to be mounted side by side with minimum of clearance required. Basic sizes of relay cover all ordinary relay needs from two to eight poles, and two magnet coils for a given voltage will cover almost any combination of normally-open and normally-closed contacts up to eight poles. Line of relays also includes 10 and 12-pole models, double deck six and eight-pole designs for use where it is more important to save horizontal than vertical space, and a special two-pole model less than 3 inches high. Poles can be converted from normally-open to normally-closed, or the reverse, in the field. **Clark Controller Co.,** 1146 E. 152 St., Cleveland 10, O.

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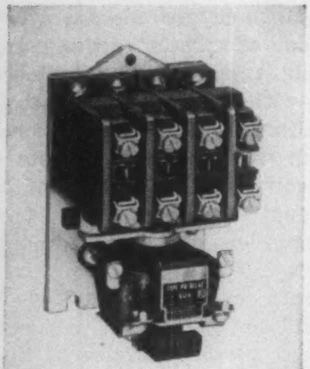

Motor Speed Control

Designed to provide stepless, reversible, adjustable speed operation of dc shunt wound motors rated up to 1/15-hp, motor speed control operates directly from existing single phase ac power lines and maintains constant torque over a wide speed range. Standard dc motors can be operated through a working range of several hundred to one, while small motors with base speeds of 500 to 10,000 rpm can be used through a speed range of as much as 1000 to 1. Speed control has the capacity required for photographic developing and printing machines, chemical process devices such as stirrers, and for general laboratory instrumentation. Delay fuse in the armature circuit affords protection against sustained overload. Motor speed control is self-contained in a steel cabinet which is self-ventilating and electrically neutral. **Opad Electric Co.,** 69 Murray St., New York 7, N. Y.

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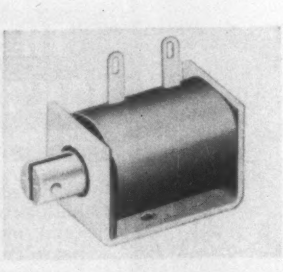
REVERSE
SPEED
SPEED CONTROL



Miniature Solenoid

Designed for limited space applications requiring high power and rugged performance, compact solenoid has shading coil embedded in plug for greater efficiency and high seated pull. It operates in any position and is supplied with solder terminals; solenoid also can be furnished with flexible leads. Unit is rated at 115v, 60 cycle ac, voltage or freqency. **Dormeyer Industries,** Dept. ANC, 3418 N. Milwaukee Ave., Chicago 41, Ill.

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New Catalogs & Literature

Engineered Filtration

*Cuno Engineering Corp.—116-page-catalog—*Solutions to more than 50 actual filtration problems are given in illustrated history section of comprehensive loose-leaf catalog. Application information and specifications for various filters and integral strainers are included in collection of bulletins at beginning of catalog. Photographs, design data and flow table are additional features.

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In-Line Handling

*W. F. & John Barnes Co.—16-page booklet—*Wide variety of special purpose materials handling equipment illustrates company's expanded service in field. Photographs, line drawings and diagrams illustrate units designed for railroad, ordnance, automotive, farm implement, electrical appliance and food industries. Diagram of cylinder block production line provides typical example of production line engineering.

Circle No. 54 on Reply Card

Remote Pressure Measuring

*Baldwin - Lima - Hamilton Corp. — 16-page booklet—*Discussion of principles of electrically monitoring and controlling line pressure through fluid pressure cells is supplemented by application photographs and schematic drawings. Pressure cells feature extreme ruggedness, high sustained accuracy and wide range of capacities. Five types of cells, available in various models, are designed to fit particular pressure applications.

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Dynamic Drying

*C. M. Kemp Mfg. Co.—40-page catalog—*Process drys gas, air and liquids by passing them through a desiccant bed, instead of moving them over the surface of an adsorbent to attract moisture from them. Principle variables of dryer design are pointed out. Available models in line are illustrated, with their specifications and design features given. Engineering data section includes charts and tables giving values for water content of saturated air at various temperatures and pressure, dew points, temperature conversions, and relations between expressions for moisture content.

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Automatic Sizing & Adjustment

*Bryant Chucking Grinder Co.—8-page bulletin—*Description of equipment which provides for automation of lines employing internal grinders is contained in two illustrated pamphlets. First of these deals with automatic sizing for constant, high production rates needed in co-ordinating production lines. Second pamphlet discusses process controller which provides statistical quality control and guarantees accurate, uniform production.

Circle No. 57 on Reply Card

Meter Relays

*Assembly Products Inc.—16-page booklet—*Contact meters provide automatic locking relays for sensitive control of many chemical processes and mechanical operations. Through either alarm, automatic shutoff, or continuous on-off control, meter relays are useful industrially for warning signals on bearing temperatures, control of electrode feed and numerous automatic speed controls on machines and conveyors. Many specific circuits for industrial applications are shown, operation explained, and components listed. Other information in booklet includes contact arrangements, polarity, contact rating, input accuracy, speed and damping, etc. Photographs and diagrams are also used.

Circle No. 58 on Reply Card

Notching Presses

*V & O Press Co. Div., Emhart Mfg. Co.—16-page booklet—*Production of electric motor laminations, circular saw blades, blower parts, jet turbine and automatic automobile transmission components are among applications of line of notching machines. Equipment illustrated and discussed includes three notching machine models, two types of segment notchers, slotting machine and band punching machine. Attachments such as skip notching unit, automatic blank feeder and index ring fixture are also covered. Press and fixture specifications are included.

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Pneumatic Control Components

*Conoflow Corp.—8-page bulletin—*Pneumatic regulators for pressure, vacuum, differential, and ratio applications are illustrated with photographs and diagrams. Filter-regulator combinations, filters, regulators, relays, purge assemblies and control panels are among precision made equipment discussed. Typical applications of equipment are included.

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Hydraulic Components

*Vickers Inc.—56-page catalog—*Solutions to many problems met in high production machinery operation are afforded by properly controlled hydraulic power. Engineering, design and application information relating to line of oil-hydraulic pumps, motors, controls and accessories are given. Photographs, cutaway views, typical circuit drawings and application recommendations, along with tables showing model designations, ratings, capacities, and typical performance curves are included. Pertinent data relating to selection, purchase and application of hydraulic equipment are listed.

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Machine Feed Units

*F. Jos. Lamb Co.—8-page bulletin—*Application of automatic material handling and feed units to standard machines provides for automation of existing production lines. Resulting installations are more flexible than large special purpose fixed machines. Bulletin illustrates how automatic stock handling in gear processing line is facilitated through use of equipment which stores parts and then feeds them automatically to next machine. Other equipment illustrated and described are orienter and bulk storage units.

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Conveying by Overhead Chain

Chainveyor Corp. — 16-page booklet — Designed for loads up to 60 lb per ft, overhead conveyor system with chain completely enclosed combines light weight with strength to provide economical, trouble free operation. Where required, conveyor can run straight up, straight down, or upside down; standard curves have 16-inch radius to centerline. Photographs and diagrams illustrate practical applications of system.

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LITERATURE BRIEFS

Combination Gives Top Quality

*Vernistat Div., Perkin-Elmer Corp.—4-page pamphlet—*Best features of ac potentiometer and variable autotransformer are combined in new unit which relates mechanical shaft rotation to electrical voltage. Features, design principles and specifications of 400-cycle component are given.

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Automatic Transfer Device

*Sahlin Engineering Co. Inc.—4-page pamphlet—*Moving of large panels between presses is facilitated with automatic transfer device. Operation of machine, which will either transfer or turn over and transfer panels, is explained in schematic drawings. Applications of device on fender skirt and roof jobs are illustrated.

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Miniaturized Electronics

*Hansen Electronics Co.—4-page pamphlet—*Development of modern electronic equipment demands miniaturization, high temperature resistance and simplified assemblies—qualities fulfilled by tape resistors. Photographs of development kit of tape resistors, ambient temperature characteristic curve and sketches are included.

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Automated Warehousing

*Walter Kidde Constructors Inc.—4-page pamphlet—*New system combines advantages of bulk picking while retaining desirable features of order picking, and is applicable to industries which must warehouse and distribute case and broken lots of wide varieties of products. Illustration of prototype system shows automated conveyor directed by electronic controls, used to facilitate bulk picking method.

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Metering Pumps

*Milton Roy Co.—4-page pamphlet—*Accurate chemical feed at low cost is possible through use of controlled volume pump, available in simplex and duplex models. Pamphlet provides specification data, pump features, and exploded view of components of unit.

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Used In Temperature Control

*Thermo Electric Co. Inc.—4-page pamphlet—*Ceramic insulation and metal sheathing give thermocouple wires great durability, high temperature rating and permit easy formation to any configuration. Terminals, seals, insulation resistance and configurations are discussed.

Circle No. 69 on Reply Card

Three-Dimensional Cams

*Parker Stamp Works Inc.—4-page pamphlet—*Automation, instrumentation, supersonic aircraft controls and other progressive fields make use of three-dimensional cams. Theory of design and cutaway photographs of typical cam are included in pamphlet.

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AUTOMATION abstracts

MACHINE COMPUTATION DOWN-TO-EARTH

By R. H. BOOTH
E. M. I. Engineering Development Ltd.
Hayes, Middlesex, England

PRODUCTION engineers are vitally concerned with control—control of materials and control of processes, which in turn means control of timing, temperature, dimensions, and many other variables. Control mechanisms of one sort or another are old and widely used, and electronics has long played its part in the process.

The main function of these controls is to keep some quantity, such as time or temperature, constant. An only slightly more complicated case is where the controller has to make one quantity directly depend on another.

None of this, however, can be called computing. What is a computer? What type of control qualifies to be called computing? For the purpose of this paper, a computer is defined as a box whose output or outputs depend on the values of two or more inputs. This type of controller can be nonelectronic, but is often electronic to some degree because combinations, i.e., multiple functions, are much more easily dealt with in that way.

In the purely manual use of a milling machine, the relative position of workpiece and cutting tool is controlled by hand setting. The blank may be fixed to a turntable and a slide moved so that at successive angles enough material is removed to arrive at the correct radius. In cutting a cam for example, this method fits a specification or drawing in which the cam is defined in polar coordinates by a table of figures and it is left to the operator to blend the successive points into a smooth line.

By successive cuts, with intervals between for inspecting what has been done, a skilled operator will be able to make a cam which will comply with the drawing. Having done so, a copy cam milling machine can be used to make further pieces.

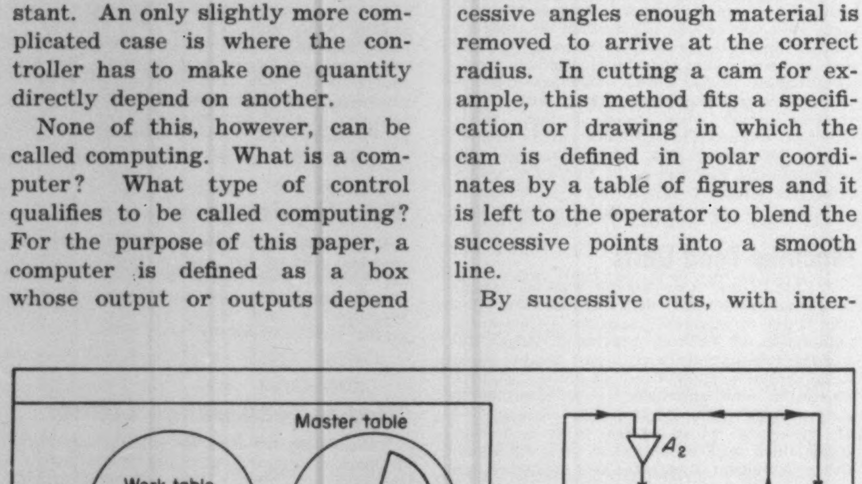

Fig. 1—Diagram of simple copying machine set up to machine a succession of cams from a master

This machine has two turntables, linked by a longitudinal shaft so that they turn together. One table, as before, carries the work being machined, but instead of being manually controlled, its slide position is held so that the distance between the tool and the center of the table is the same as that between the center of the other table and a fixed copying stylus. To do this requires only a simple proportional servo system, with the pressure on the copying stylus (converted to infinitesimal movement) giving rise to motor drive on the lead screw controlling the slide position. In *Fig.* 1, pressure on the stylus S from the master M is amplified in A_2 and provides the motive power for the motor M_2; this is geared to the lead screw L_1 and if the sense (positive or negative) of the connection is right, the system will operate at any point round the periphery to keep the pressure on the stylus substantially zero and thus keep the other table away from the cutting head by an amount equal to the radius of the master at that point.

There has intentionally been no mention of how the pressure on the stylus is converted into motive power of the motor. Indeed there need be no motor, in the sense of a unit providing rotary motions to a leadscrew. The stylus could operate a hydraulic system in which it released substantially greater oil pressure which directly propelled the table. Or the pressure could be converted in various ways into a voltage, which is amplified to drive an electric motor. As long as only the simple proportional control is wanted, it does not matter which is done.

But suppose an extra requirement is added—that when a steep cut is being made, the table speed is to be reduced so as to avoid excessive linear cutting speeds. This is not so straightforward hydraulically, but can easily be carried out electronically.

A transducer T is used to convert the pressure on the stylus S into electrical voltage, and there is a tachogenerator G_2 to provide velocity feedback for stabilizing purposes in accordance with the dictates of ordinary servo theory. This same generator is used to control the speed of the table motor M_1. As shown, this motor will run so that the sum of the voltages from the potentiometer P and the longitudinal generator G_2 (as modified by the function box f) balances its own generator voltage from G_1. If f is set so as to attenuate G_2 completely, then the speed of M_1 will be simply proportional to the potentiometer setting, but as G_2 is allowed to become effective, it will act so that an increase in radial speed will reduce the demanded speed from P and so the actual speed of M_1. The latter is now controlled from more than one source and so there is a computer, however elementary, at work.

In spite of this complication, the positional control of the table has remained a simple one. But if automatic control of this machine is carried a stage further to the extent that it needs no master to work it but can use information direct from a drawing, then it will be found that the position of the table has to depend on more than one item of information, and there is still more computation.

Information on a drawing is rarely continuous, particularly when it is for a contour of this sort. Usually the information is in the form of a table of figures and as such it must be fed into the machine. Well-known techniques for recording information for machine purposes exist — punched cards, punched tape or magnetic tape can be used.

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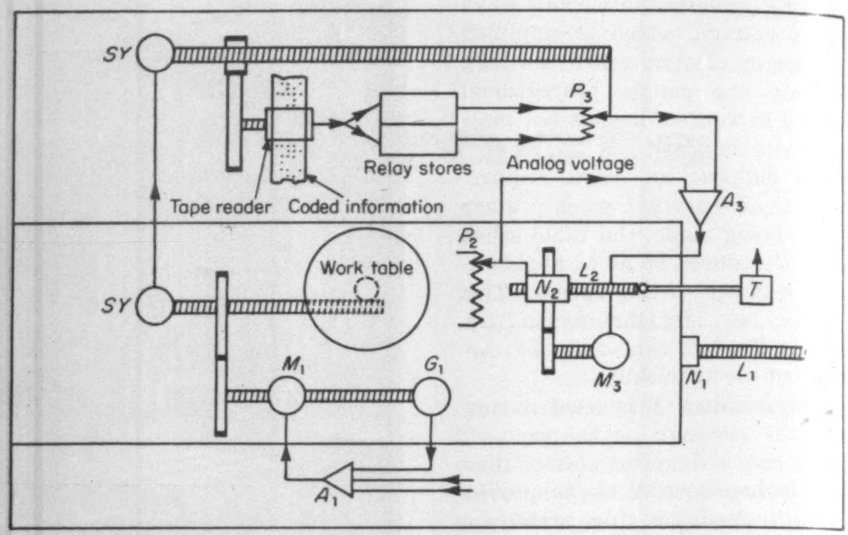

Fig. 2—Modification of the machine shown in Fig. 1 with tape input and linear interpolation replacing the second turntable

When the hole pattern has been read by the machine, it cannot be used in isolation to control the table position. If it were, the table could do no more than proceed in a series of jerks from one dimension to the next, and could only produce some semblance of the required shape if the points on the tape referred to angles extraordinarily close together.

If, however, two points are used by the machine at a time, then as soon as it has read the first pair it knows where it must go next and can act appropriately. It can draw a straight line from one point to the next and proceed along it. This is a rather anthropomorphic argument but can be turned into terms more appropriate to engineering. Consider the block diagram in *Fig.* 2. The second turntable has been removed and replaced by a leadscrew L_2 working in a nut N_2 and bearing on the copying stylus. It also reproduces a feedback voltage from a potentiometer P_2. The motor M_3 drives the leadscrew until this voltage balances that from potentiometer P_3 which is derived from the tape.

The arrangements for driving the turntable are unaltered, but a synchronous link, *SY*, has been added between the table and the tape reader. The latter thus proceeds from line to line on the tape as the table rotates, which is equivalent to running down from line to line in the table of dimensions, and as a new line comes in, it is retained or "remembered" until the next line is available and is the means whereby two points on the contour being machined are used together.

Advantage has been taken in the relay stores of other contacts to obtain voltage outputs. This is done by using each relay to switch in a voltage proportional to the significance of its digital or hole position. The two voltages can now be applied to opposite ends of the potentiometer P_3, whose slider is driven with the tape reader from the synchronous link. A duplicate of P_3 may be used to assist change-over from a pair of points to the next pair.

The overall effect of this circuit is to extend the leadscrew L_2 by an amount equal to the radius of a polygonal figure composed of lines joining the successive points represented by the dimensions in the table, this radius varying uniformly between adjacent reference points.

With this system there will be no sudden jumps in the position of the leadscrew L_2 and the main servo system will continue to drive the leadscrew L_1 so that the table takes up a longitudinal position relative to the cutting tool corresponding to the polygonal figure.

Although there are no sudden jumps in the position of L_2 its rate of movement will change suddenly as each new point comes in, and this means that the resultant shape has sharp corners. This can be remedied if we allow the machine to take notice not only of the next point, but of the one after that as well, so that the curvature of successive lines, each now passing through three points can vary in such a way as to make each touch or blend with its neighbor. There will now be, in general, an abrupt change of curvature when two lines join, but this is a far less serious matter than an abrupt change of direction.

To make use of three points instead of two requires extra relay stores, *Fig.* 3, and a unit called a parabolic bridge. Examination shows that there are two independent loops. One, comprising A_3, M_3, N_2 and P_2, keeps the leadscrew L_2 at a place dictated by the tape; the other consists of L_2, T, A_2, M_2, L_1 and N_1. It positions the table on the instructions of L_2 and thus, indirectly, of the tape. The first loop can be eliminated by putting P_2 on L_1 and then using the output of A_3 to drive M_2. The disadvantage of this arrangement is that all dimensional accuracy is referred to a leadscrew (L_1) which bears a considerable load and which is therefore more subject to backlash errors.

Analog Computing

During the course of the imaginary development just described, a simple manually controlled milling machine has been turned into an automatic machine, capable of milling a cam controlled by a piece of tape produced by a typist from a table of dimensions. This has been possible only because automatic computing facilities have been introduced and controllers take account of information from various sources including internal stores or memories and use it all for guiding the machine's future actions.

This computing has been analog computing. It is so called because there is always a physical representation, an analog, of the quantity being computed, in another physical form. The most usual one, and the one employed here, is the representation of length or angle as an electrical voltage. This is common because of the ease with which voltage is converted to

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and from other physical quantities, e.g., from angle of rotation by means of a potentiometer, and the ease with which different voltages can be combined and modified, particularly if alternating voltages and transformers can be used.

With a physical quantity, whether a length or a voltage, there is a limit to the accuracy with which it can be known. This is not important in computing, providing that the analog quantity, in the present case voltage, can be known more accurately than that which it is representing. Jig borers apart, it is doubtful whether machine tools can be considered more accurate than one part in ten thousand (0.001 inch in 10 inches). A new technique has recently been evolved which enables voltages (strictly speaking, their ratios) in electrical computing circuits to be manipulated to an accuracy of one part in fifty thousand.

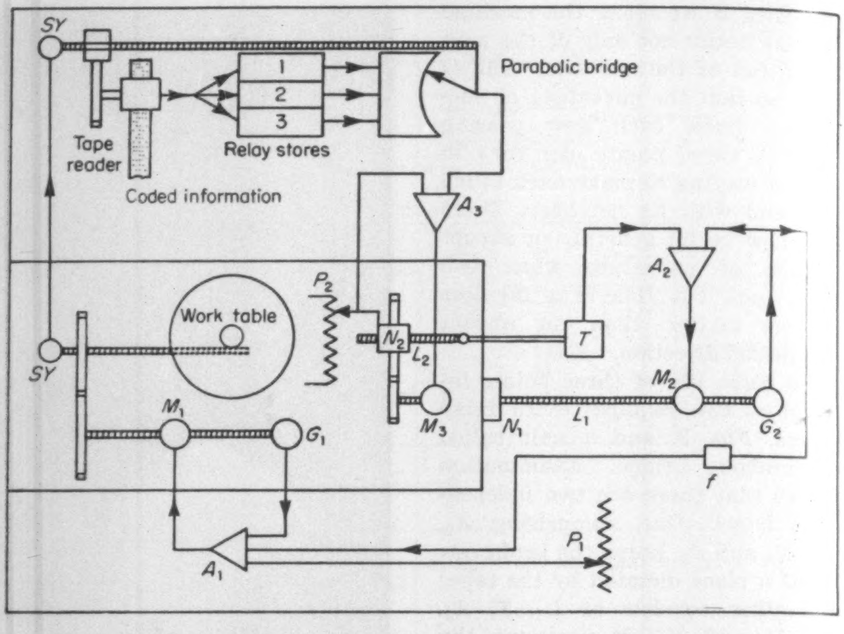

Fig. 3—Completely automatic machine tool with parabolic interpolation. A parabolic bridge arrangement is a system in which voltages are available from stores in values lying on a parabolic curve

Analog computing is also particularly appropriate when it is necessary to control physical quantities which can vary continuously, such as the table position in the machine tool. When, however, artificial concepts such as money are involved, analog computing ceases to be so apposite, because with unnatural or nonphysical quantities there is rarely a limit of accuracy which can be unambiguously stated, and the quantity rarely changes continuously. In these cases digital computing is appropriate. It is much more similar to conventional calculation, abacus or bead frame—methods which were primarily developed for financial reckoning.

Digital computing deals in numbers, in states, in "is's" and "isn't's," not in quantities. A digital computer is not in general concerned with how many volts there are on a wire, but whether there is a voltage or not. Ultimately, of course, there must be a limit at which one says, "above this is something, below nothing," but successful design ensures that this limit is rarely if ever approached from either direction.

Analog computing was considered as applied to an individual machine tool, to the direct control of the physical process. Digital computing may be used to extend this control to the working of the whole factory.

From a paper entitled, "The Computer — Electronics Contribution to Production" presented at the Automatic Factory Conference of the Institution of Production Engineers in Margate, England, June, 1955.

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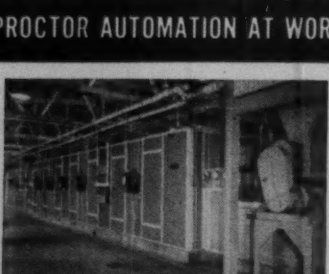

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MAINTENANCE IN PRACTICE

By LEWIS P. RANDALL
General Motors Corp.
Trenton, N. J.

A PREVENTIVE maintenance program can be defined as one in which equipment is inspected, tested, and reconditioned at regular intervals to prevent failure in service and to retard deterioration. The interval is set on the basis of experience, with the character of the equipment, the service conditions to which it is subjected, and its importance in the production process taken into account.

The die cast department of our plant operates 32 machines with 250 to 750-ton locking pressures and each capable of making from 300 to 600 shots per hour, casting from 1500 to 1800 pounds of zinc base die castings per hour. In 1945 and '46, during reconversion from airplane production to our normal function of automobile hardware production, the need in this department for a formal program was foreseen and mortality records were started. A formal Preventive Maintenance System was officially started during 1948 in our die cast department. Downtime was reduced from 14 per cent in 1947 to less than 1 per cent in 1949.

With these results, it was relatively easy to sell management, production, and maintenance supervision on extending the preventive maintenance system to cover the entire plant. An engineer and clerk were hired for the full time assignment of initiating and coordinating this plant-wide program.

Paperwork

To be effective, every preventive maintenance program must be operated by an efficient, thorough and economical system that will make possible an effective accomplishment of program aims. Three categories included in such a system are: Schedules, job instruction sheets, and records. It is well for the person initiating a new program to keep in mind that fail-

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ure to include every phase of the system in one form or another will, in time, void the entire system.

There should be at least two types of schedules for a system: One in book form, listing the equipment to be inspected, location and the date of inspection; the second, a card schedule, to be kept in a master file maintained by the person issuing the inspection sheets. Although it is not essential to have a card schedule in addition to the master schedule, it has been found to be a very satisfactory method of determining when inspections are due and provides a cross index for locating inspection sheets. Copies of the book type schedule should be distributed to supervision of the departments which operate and maintain equipment covered by the system and to other people interested in the equipment.

The card schedule in most systems serves as the actual reminder as to when inspection for equipment is due. This file can take the form of a Cardex system where all of the equipment covered by the system is represented with an individual card. One way of determining when the equipment is due for inspection is by using the movable colored tabs on on the cards indicating the day and month of the next inspection.

Another very convenient form of card schedule can be made as follows: Job instruction sheets can be filed in calendar order so that when the clerk handling the paper for a system opens the file to the present day of year, the equipment to be inspected will be found in the folder for that day and can be disbursed to maintenance. When the cards have been returned, they are refiled according to the next inspection date. It should be noted that a cross index for the calendar file is needed so that equipment within the file can be located by some convenient form, such as equipment number, etc., rather than having to search the file at random.

The job instruction sheet varies only as to the degree of job explanation, from the extreme of telling the mechanic only that he is to inspect a machine, to the other extreme of detailing the removal of every nut and pin necessary to complete the inspection. Either of the two extremes mentioned could be satisfactory, but, success would depend upon the caliber of the mechanic making the inspection.

A reasonable solution to the problem is to state in the instruction sheets the components of the machine that are to be inspected in a rather cryptic form—that is, gears, belts, motor, couplings, etc., and then under separate cover, supply the mechanic with detailed information as to what is to be done in the particular cases. In this manner the skillful mechanic will not be offended by trivial details on instruction sheets while the less skilled man will be able to obtain the information needed to do a thorough inspection job. Actually, the job instruction sheets will probably fall into a category somewhere between cryptic instruction and detailed instruction with the type of personnel performing the inspection being the

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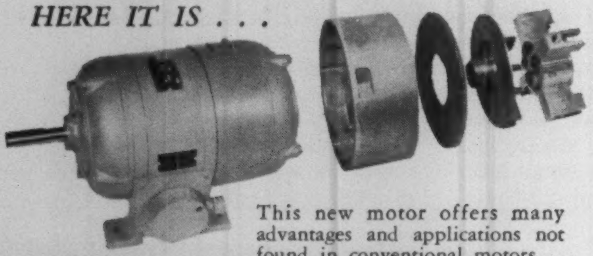

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determining factor.

When making up the initial inspection sheets for a system, information may be obtained from a number of sources, such as manufacturer's recommendations, past maintenance experience with the machine, visual inspection of the unit and operating complaints. It is probable that the first instruction sheet will be far from the ideal thing but, through constant review of the system, the instructions can be revised into more suitable form.

Basis for Improvement

The purpose of records in conjunction with a preventive maintenance system is to provide a tool whereby responsible people who review these records can check the effectiveness of the system and make necessary improvements. As a by-product, machine performance can be improved, down-time reduced, life of parts of the equipment can be determined and replacements ordered only as required.

Records should contain both information gathered during inspections and a record of all machine breakdowns, plus any miscellaneous repairs not covered by the inspection or breakdown. It is obvious that such information should be available to persons purchasing new machinery, machine design personnel, accounting, and maintenance. The inspection system will benefit by the fact that these records point up critical items that must be carefully inspected if machine down-time is to be controlled.

Experience at the General Motors Ternstedt-Trenton Plant and many other plants throughout the country has demonstrated the cost-saving possibilities of an effective preventive maintenance program. No one program will fit all plants. Each type of operation requires modifications of the basic program.

We believe in preventive maintenance. We also believe that management, production, and maintenance must all be sold on it before it will be very effective. The record is clear where preventive maintenance has been given a trial in the proper atmosphere.

From a paper entitled, "A Preventive Maintenance System and Its Operation" presented at the Machine Tool Conference of AIEE in Detroit, Oct. 1954.

". . . take time out to see what is on show, and while here particularly look out for one of the most spectacular exhibits at the (Margate) Conference. It comes in a variety of sizes and specifications, weighing in its medium size about 160 lb. It has a built-in computer complete with a fine memory unit and feedback controls. I would particularly ask you to examine its servo control system and the ease with which it can be adapted to a wide range of jobs. Unfortunately, it does require quite some skills to get full output from it but once set and reasonably maintained it performs a fine job. It has, too, the advantage that it can be reproduced by comparatively unskilled labor. Its name? A three-letter word beginning with 'M' . . ."—*Walter Puckey, president, Institution of Production Engineers, England.*

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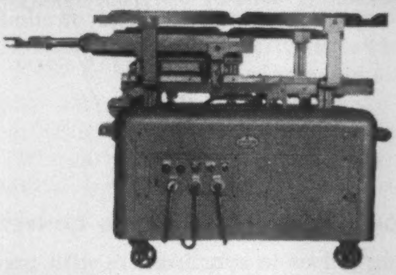

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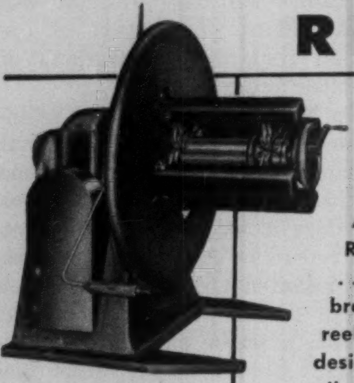

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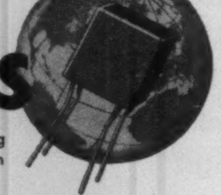

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AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Components

RECIPROCATING ELECTROMAGNETIC PUMP

Pump has a hollow magnetic piston slidable in a cylinder. A spring urges the piston toward the outlet and a solenoid can be operated to retract the piston. Patent 2,716,381 by Leland C. Parker, assigned to Bendix Aviation Corp.

FLUID PRESSURE ACTUATED DEVICE HAVING A NUMBER OF PREDETERMINED POSITIONS

Actuating device comprises a combined cylinder and piston reciprocable within a larger cylinder. Various ports give desired action. Patent 2,716,965 by Paul Klamp, assigned to Mechanical Handling Systems Inc.

ROTARY FLUID DISPENSING MECHANISM FOR CLEANING ELECTRICAL CONTACTS

Stream of cleaning fluid can be forced through hub of rotating switch to clean circumferentially disposed contact points of the switch. Patent 2,719,204 by Murray Brown.

◆ ◆ ◆

Controls

CONTROL SYSTEM FOR TRAVELING CONVEYORS

Timing pulses in synchronism with travel of conveyor sections control transmission of destination signals which selectively actuate ejector devices to remove articles from the conveyor at preselected unloading positions. Patent 2,717,086 by George L. Bush, assigned to Teleregister Corp.

WIRE CUTOFF CONTROL

Two limit switches actuate cutoff means. The switches are operated by a length registering device and no delay for reset is required. Patent 2,716,818 by Lester D. Fitler, assigned to Rome Cable Corp.

AUTOMATIC DENSITY REGULATOR

Apparatus automatically regulates density of a liquid suspension of ultra-fine solids in water.

Variation of impedance in induction coils depends on hydrometer position and controls flow diversion to a thickening circuit. Patent 2,717,078 by Cass B. Levi, assigned to McNally-Pittsburg Mfg. Corp.

◆ ◆ ◆

Handling

CONVEYING APPARATUS FOR CARTONS

System slits and opens sealed cartons, imprints data on the contents of the open carton, and reseals the cartons. Patent 2,718,106 by Frank J. Hooffstetter and Harold C. Newberry.

DEVICE FOR STORING POURABLE SOLID STOCK SUCH AS SHAVINGS, FIBERS, SHREDS, AND THE LIKE

Bin structure dispenses material stored in a pile normally of a given height with variable horizontal length. Bottom and top of the storage area are endless conveyors. A vertical scraper conveys stock to the outside. Patent 2,717,703 by Walter Kull and Klaus Steiner, assigned to Allwood Inc., Glarus, Switzerland.

MULTICONVEYOR PATH FEEDER BOWL

Feeder bowl for vibratory feeder has a plurality of helical conveyor tracks to discharge parts simultaneously at a common point. Patent 2,718,957 by William V. Spurlin, assigned to Syntron Co.

◆ ◆ ◆

Machine Tools

AUTOMATIC FEED MECHANISM FOR MACHINE TOOLS, ESPECIALLY GRINDING MACHINES

Twisting of a torsion bar in the drive to a rotary tool actuates a means to drive the tool independently of the bar and a means to alter the speed of the feed of the tool toward the work. Patent 2,718,100 by Eric G. Hjarpe assigned to SKF Industries Inc.

DIE-CUTTING PRESS WITH AUTOMATICALLY VARIABLE TRAVEL OF WORK TABLE

Horizontally reciprocable table supports work material upon which a cutting die is required to be positioned differently for each cutting operation. Patent 2,718,260 by Stewart F. Oakes, assigned to Hobbs Mfg. Co.

◆ ◆ ◆

Process Design

METHOD OF MAKING PRINTED CIRCUITS

Die forms desired circuit by embossing foil into uncured base. Base material is cured, then unembossed portions of the foil are abraded away. Patent 2,716,268 by Oliver I. Steigerwalt, assigned to Erie Resistor Corp.

MOLD BAKING METHODS

Uncured shell mold of thermal setting plastic and refractory filler while attached to a pattern is baked by submersion in a bath of molten metal. Patent 2,712,165 by Walter H. Dunn and Conrad C. Wissman, assigned to Solar Aircraft Co.

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You'll find machines of the types pictured on this page in current use in plants bearing America's foremost industrial names.

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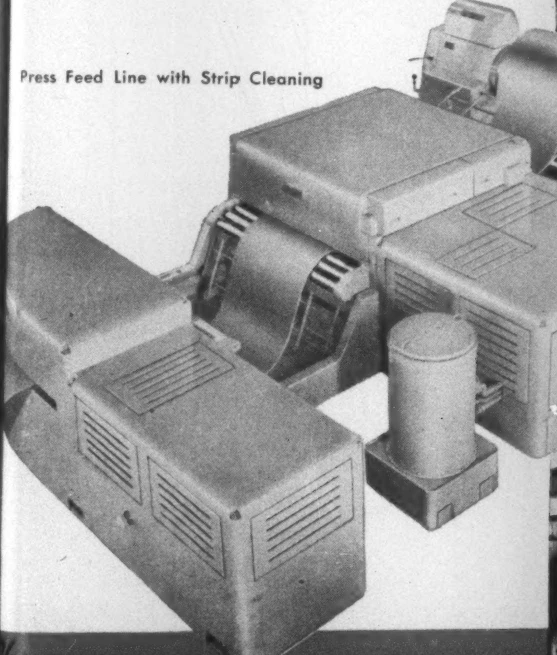

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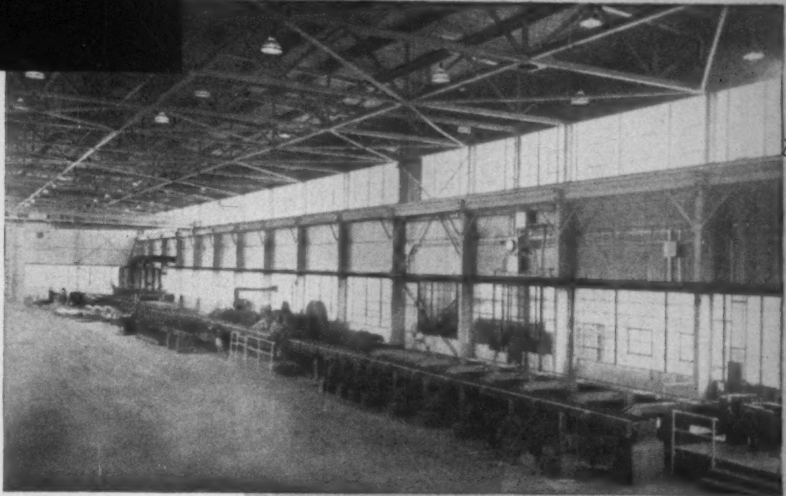
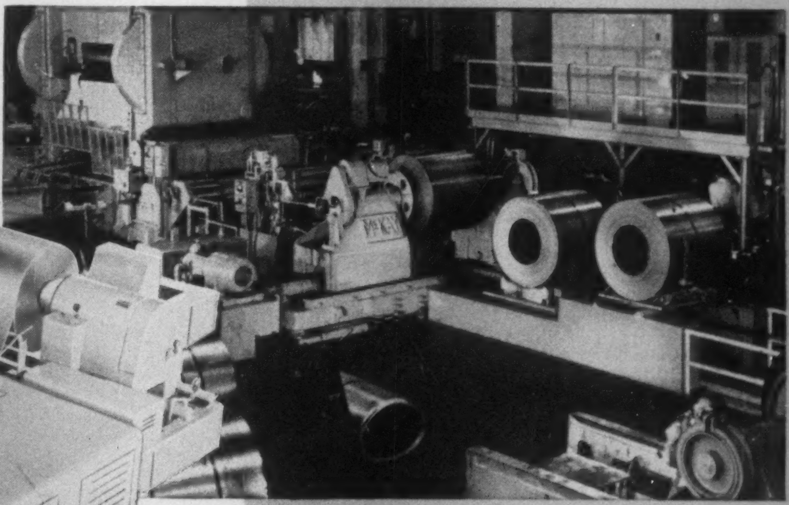
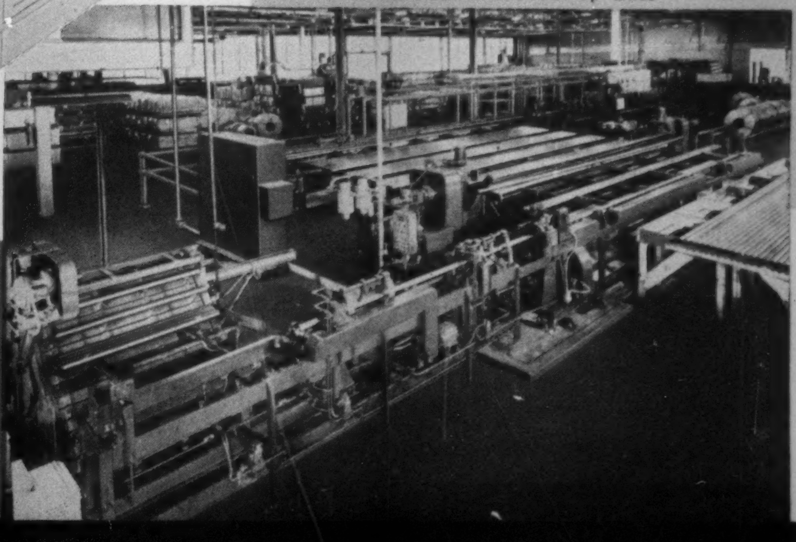


Automatic Cold Draw Lines



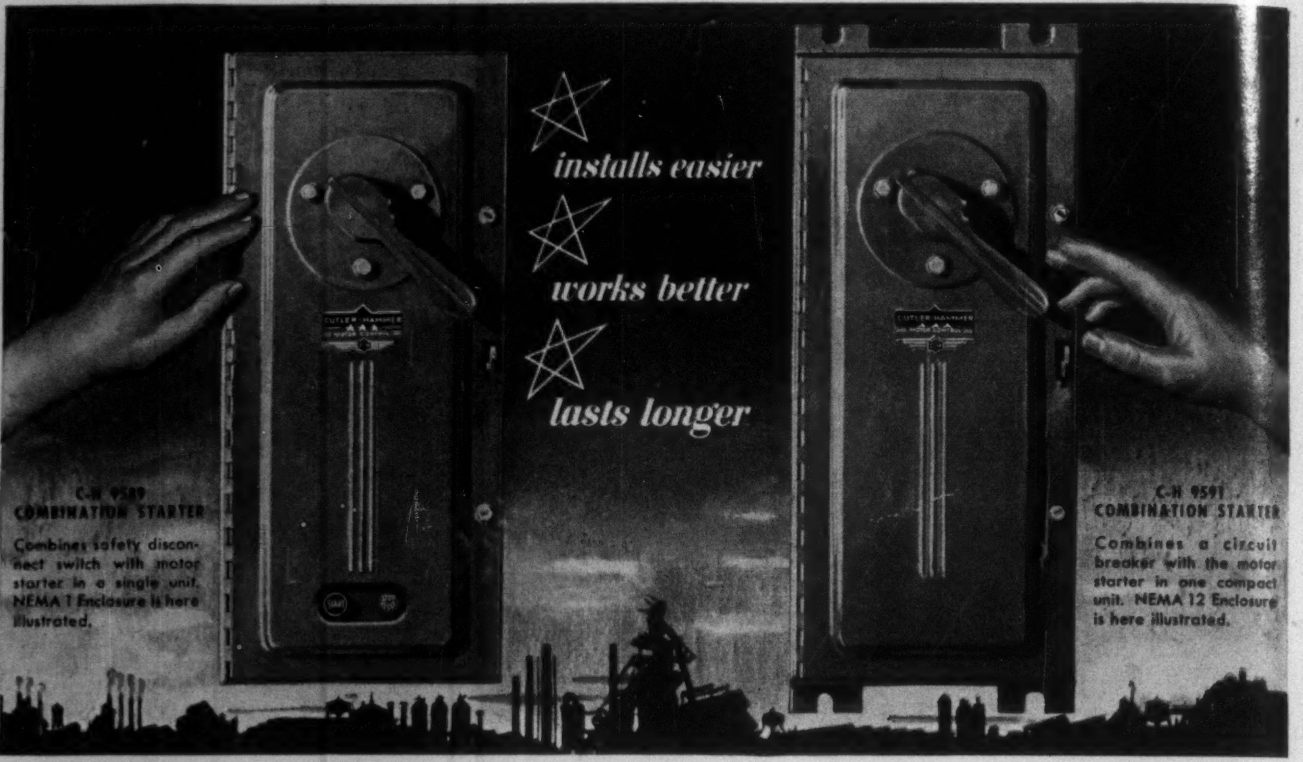
Automatic Press Feed Lines

Automatic Tube Cut-Up Lines



WHAT'S NEW IN MOTOR CONTROL? ★ ★ ★ GET IT FIRST IN CUTLER-HAMMER

New Cutler-Hammer Three-Star Combination Starters offer industry important new economies



C-H 9589 COMBINATION STARTER

Combines safety disconnect switch with motor starter in a single unit. NEMA 1 Enclosure is here illustrated.

C-H 9591 COMBINATION STARTER

Combines a circuit breaker with the motor starter in one compact unit. NEMA 12 Enclosure is here illustrated.

Convenience and economy are basic advantages of combination starters. Users everywhere say the new Cutler-Hammer ★ ★ ★ Combination Starters bring these basic advantages to new high levels of importance. Contact life is so amazingly improved that maintenance care is *never* needed in all normal uses. Adjustable load sensing coils permit motors to work at top capacity without hazard to provide maximum production without needless work interruptions. And the widely praised Cutler-Hammer exclusive, full three-phase overload protection in standard combination starters, is optional at slight additional cost.

The three silver stars stand for three new standards

CUTLER-HAMMER
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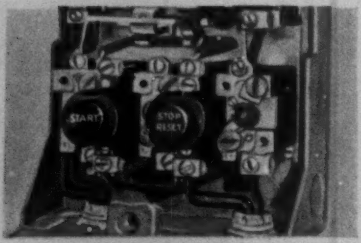
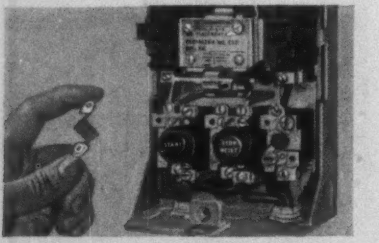
Compare the performance and economies of these remarkable new Cutler-Hammer Three-Star Combination Starters with any you have ever known. Cutler-Hammer Bulletin 9589 Combination Starters incorporate rugged disconnect switches of advanced design (fused or unfused). Cutler-Hammer Bulletin 9591 Combination Starters are equipped with circuit breakers. Your nearby Cutler-Hammer Authorized Distributor is stocked and ready to serve you. Order from him today.

CUTLER-HAMMER, Inc., 1466 St. Paul Avenue, Milwaukee 1, Wisconsin.



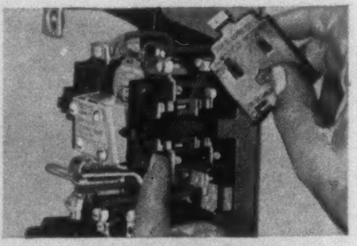
Full Three-Phase Protection

Only *three* overload relays can give complete three-phase protection to avoid motor burn-outs and their costly interruptions to production. And only Cutler-Hammer offers this complete three-phase protection in standard combination starters. You pay only for the third relay, nothing extra for special engineering or special enclosures.



Adjustable Load Sensing Coils

The accurate adjustment of overload protection permits motors to work harder without damage to motor windings. This is more important than ever with the newer type small frame motors. Adjustable load sensing coils in these new starters provide 3% loading accuracy instead of the 10% to 12% accuracy in competitive control.



Superlife Vertical Contacts

Experienced control users insist on dust-safe vertical contacts. And now the famous Cutler-Hammer vertical contacts have been doubly improved. First, their new lightweight design cuts bounce to reduce arcing. Second, any arcing that might occur is now pressure-quenched. Compare performance and see the difference.